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30

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PLUS! 12 EPIC fails**

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ISSUE 360

FUTURE

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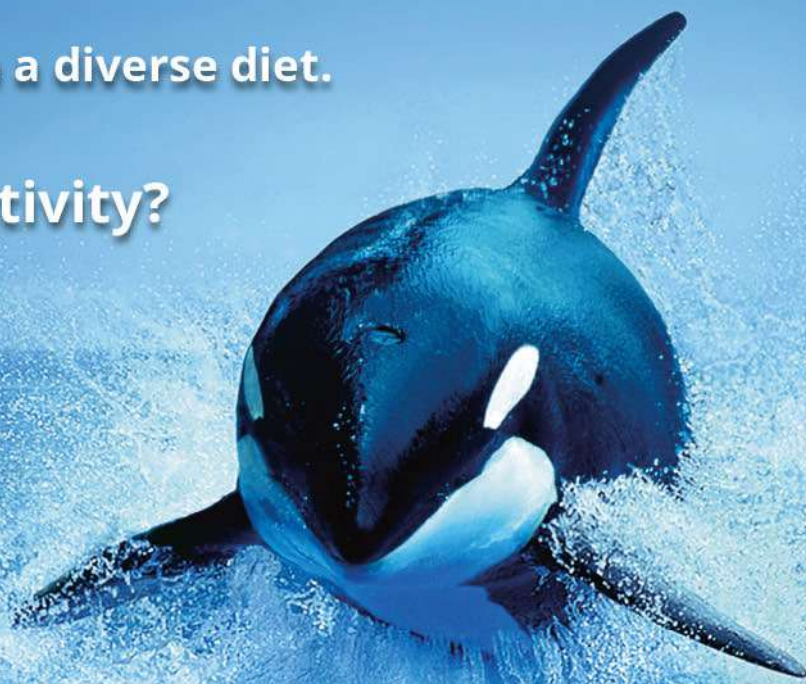
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HIGHLIGHTS THIS MONTH

Full contents overleaf



REVIEW OF THE MONTH

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Microsoft Surface Laptop, 7th Generation

We have a feast of Copilot+ PCs this month – including the lovely Lenovo ThinkPad T14s (see p56) – but Microsoft's pair of machines are arguably the most lip-smacking. First is the latest Surface Laptop, which comes in 13.8in and 15in incarnations, and it will come as no surprise to Surface fans that this machine oozes quality. We've also put the new Surface Pro, complete with OLED screen, through our tests. Find out which whets your appetite from p50.



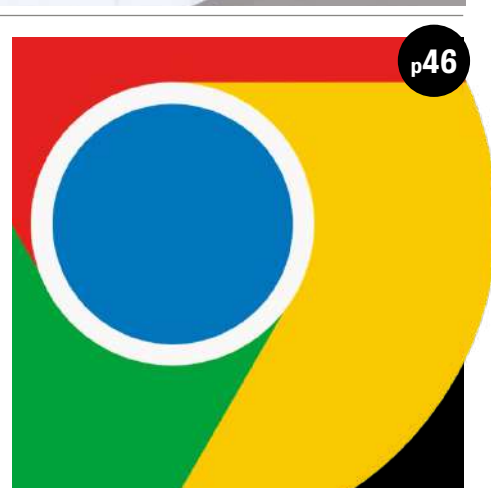
CELEBRATION OF THE MONTH

To celebrate *PC Pro*'s 30th birthday, we look back over the biggest moments in technology – and the worst fails – from 1994 to the current day.



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LIFESAVER OF THE MONTH

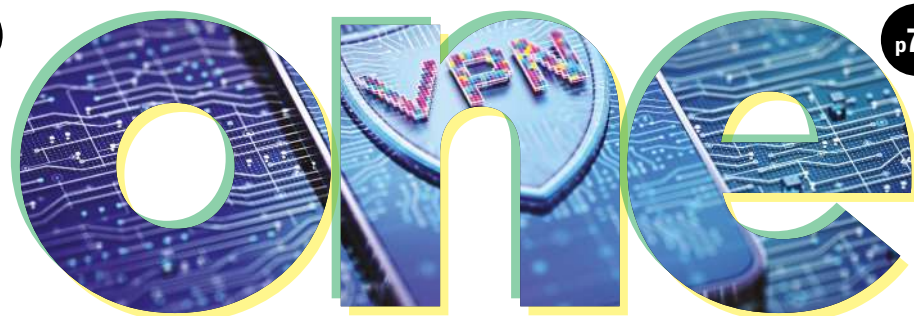
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THE LABS IN ONE NUMBER

One intercepted password, one holiday unable to access iPlayer, one file that falls into the wrong hands. We all have our one reason for wanting a VPN, so read our Labs to discover the right one for you.



30th ANNIVERSARY SPECIAL EDITION

PC PRO

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- Best for security



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30 GREATEST MOMENTS IN TECHNOLOGY

**Era-defining products Tech breakthroughs
PLUS! 12 EPIC fails**

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NEW Surface Laptop & Surface Pro

Now with built-in AI and best-ever battery life



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Listen live to the *PC Pro* podcast every Thursday at 1pm. Join us at pcpro.link/discord

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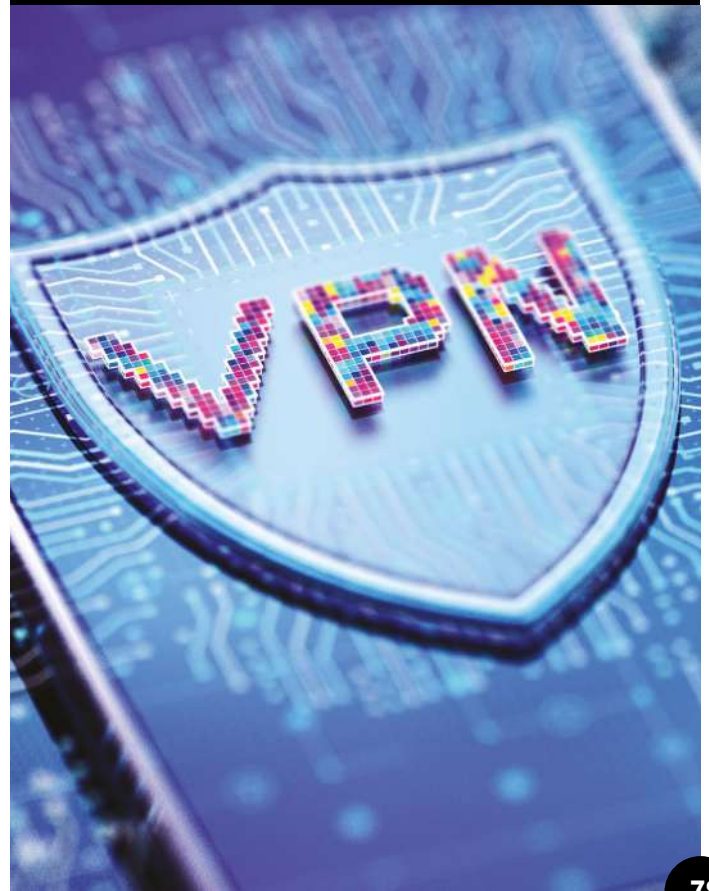
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Now that's what I call incredible technological progress

It's the morning on which we send the magazine to press, the 360th such morning this monthly magazine has enjoyed. You would think it gets easier. Smooth, even. But I can tell you with so much honesty it would make a judge weep, that every issue I've ever been involved with stumbles over the line, leaving me a mumbling wreck in its wake.

I like to think that it's because this is a cutting-edge technology magazine, one that includes the latest releases, so we must do it this way. And there's an element of truth in this: we do our very utmost to review the latest products in the magazine, even if that means making our production editor Steve pore over stats and words minutes before we're due to send the pages to the printer (sorry Steve).

While producing each issue is a huge challenge, there is a beauty to it. Every single magazine we've printed over the years becomes its own time capsule, capturing the month's events, whether that's investigations – such as our report into the dangers of expired domains (see p12) – or through the emails we receive. For instance, this

month we're indebted to Peter Jones, who gives a first-hand account of the impact that CrowdStrike's update had on the general practice where he works. Read all about it, as they say, on p24.

After that, I hope you turn to our trip down memory lane in this month's mammoth feature about 30 great moments of technology (see p26). We've given this a tongue-in-cheek title to echo one of my fondest childhood memories, those huge compilation albums that were popular in the 1980s and 1990s before the internet changed everything, but in its own way this does the same.

We've picked out the "best" events in the 30 years since *PC Pro* launched in 1994 and – no doubt echoing my disgust when the taste makers behind *Now That's What I Call Music* decided to put Tina Turner's "What's Love Got To Do With It" on *Now 4* – I suspect you may read through our picks and shake your head in despair. All I can tell you is that an awful lot of history was left on the virtual cutting-room floor, for which I can only apologise.

Perhaps our most controversial pick comes right at the end: Copilot+

PCs. Just like Intel's ViiV initiative, Google+ and UMPCs (none of which made it to our final list, incidentally), this industry-led initiative may well be consigned to the remainder bin of technology "revolutions". And ultimately, even I think the term will fade into obscurity, because the built-in AI that Microsoft aims to emphasise by labelling computers in this way will become commonplace. In five years' time, all processors will include AI accelerators, and we won't even think of it as being special. It will just be what computers do.

Instead, what Copilot+ PCs really signal is the arrival of a third CPU maker for Windows computers in the form of Qualcomm. And allow me to make a prediction: it's here to stay. If you don't believe me, turn to p56 and my review of the Lenovo ThinkPad T14s – a 1.2kg business laptop with 24-hour battery life. If that doesn't give an idea of just how far we've come in 30 years, I'm not sure what does.

Tim Danton
Editor-in-chief

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This is the 30th anniversary of *PC Pro*, so we asked our contributors for their stand-out memories of their time working for the magazine.

"When I was asked to be editor, back in 2004. I was sitting in Heathrow airport testing a laptop at the time, and was so shocked that I put it in my rucksack, forgot to close the zip, stood up, and the laptop promptly fell onto the floor, breaking its screen. I then had to stump up £400 to fix it!"

"Meeting with Felix Dennis [founder of Dennis Publishing] after US giant Ziff-Davis announced it was launching its computer titles in the UK, preparing the ground by snaffling almost all the freelance computer journalists on retainers to keep them from us. We decided to take a chance by recruiting a bunch of the smartest nerds from Cix instead..."

"I will always remember my very first assignment, when I was tasked with putting together a 14-page Labs roundup of laser printers. As part of my testing kit, I was supplied with about a dozen reams of A4. 'Why do I need such a huge amount of paper?' I asked. 'How else are you going to find out which toner cartridge lasts longest?' came the answer. I guess until then I hadn't fully appreciated what 'real-world testing' meant."

"Microsoft sent us a press release announcing the launch of Outlook.com and within five minutes we'd managed to bag steveballmer@outlook.com, because the company forgot to reserve the name of its own CEO. I've still got the email from the PR team, politely asking us to hand it back (which we did)."

"PC Pro has been a big part of my life: I met my now-husband when he interned for us! But one tech moment that stands out is trying on Google Glass – so incredibly bad, like a broken TV across the room, that I thought I'd broken it. But it wasn't me, it was them. That moment solidified my belief that much of tech is overhyped nonsense."

"I extended my stay at the end of a US factory tour and hired a car for a solo road trip. Within 24 hours, the car was a wreck and I'd made friends with the local police. Don't remember much about the factory."

"Upsetting a major software company so very badly that it withdrew advertising for some months, costing Dennis a lot of money. Felix's response was 'f***em'."

"The memory that shines bright for me dates back to 1995 when I wrote a feature called 'Threats to the Internet', looking at everything from censorship to commercialisation, from privacy to surveillance issues. The following year I somehow won the Technology Journalist of the Year award for this feature, against stiff competition from writers contributing to *The Times*, *The Economist* and *New Scientist*. Fast forward to 2011 when I won the Enigma Award for a 'lifetime contribution' to the sector. *PC Pro* gave me a stage and a voice, for which I will be forever grateful."

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Briefing

Background and analysis on all the important news stories

Foldables fail to find pocket space

Six years on, foldables remain a marginal luxury – and price cuts might not help



The recent launch of the Samsung Galaxy Z Fold6 (see p72) was a stark reminder that foldables aren't exactly cutting-edge technology any more. First launched in 2019, and after five generations of refinement, folding phones are still an expensive niche that will account for a mere 1.5% of smartphone units sales in 2024, according to analysts TrendForce.

Experts suggest several reasons why foldables have so far failed to woo consumers, not least their premium price. But the cheaper foldables now breaking into the market could do more harm than good for the technology's long-term prospects.

Disappointing start

Industry analysts say that foldable phones haven't delivered the sales manufacturers such as Samsung had hoped for. "Unfortunately, it's failed to live up to expectations," said Ben Wood, chief analyst with CCS Insight, of foldable technology.

"In a market of a billion smartphones it [foldable technology] is very small," Wood added. "Samsung is one of the big players, kind of the market leader. But you're still only talking about millions of units [shipped], not tens of millions of units."

The fact that Samsung is still putting devices such as the Galaxy Z Fold and Z Flip front and centre at major product launches shows it's not about to give up on the technology, though, despite the disappointing sales. "They are still strategically very important products to Samsung, not least because of the fact that they offer the ability to provide some very clear differentiation from Apple, which is hugely important," said Wood.

Why have foldable sales failed to ignite? There's a range of reasons, but it's hard to escape the obvious one: price. Far from getting cheaper as the technology matures, Samsung actually increased the price of the latest generation of its Fold and Flip phones to £1,799 and £1,049 for the base versions respectively.

Market watchers say the price rises weren't driven by the cost of the screen technology. "With its latest foldables, Samsung hopes improved materials and better camera hardware, combined with Galaxy AI features, are enough to convince buyers of the \$100 increase in price versus last year's models," said Ankit Malhotra, senior analyst at Counterpoint Research.

ABOVE Samsung's Galaxy Z Fold is still going, despite disappointing sales



Still, the price rise is hardly likely to drive a rush of new sales.

It's not only the upfront cost that consumers are wary of when considering foldables, either. "There's a nuance to price, which is not only is it an expensive upfront purchase, but the residual value of foldables when you come to trade them in, which more and more consumers are starting to understand," said Wood.

"If you buy an iPhone now, you know you can trade it in in two, three years' time, or even four years' time, and get quite a good chunk of change back towards your next purchase. What we're seeing with foldables is they're not holding their value in the same way," largely due to question marks over their longevity, Wood added.

Although Samsung is the biggest name in the foldables market, it's not the biggest seller. Huawei overtook

Samsung to become the leading global foldable smartphone seller in Q1 of this year, according to

“Why have foldable sales failed to ignite? There's a range of reasons, but it's hard to escape the obvious one: price”

figures from Counterpoint Research. Other Chinese manufacturers, including Honor, have also made huge recent gains in shipments.

In fact, China became the biggest global market for foldables in 2023, helping to offset the tepid reception they're getting in the West. And that's not necessarily due to the Chinese manufacturers undercutting Samsung on price, either. "Huawei achieved a remarkable 257% year-on-year growth this quarter, driven largely by its transition to 5G technology in foldable devices," said Ankit Malhotra.

"A year ago, Huawei's foldable lineup was exclusively LTE-based. However, by Q1 2024, 84% of their foldable shipments were 5G-enabled. The Mate X5, Huawei's first 5G book-type foldable launched in September last year, has consistently been a top seller in China's foldable market. Additionally, the introduction of the Pocket 2, Huawei's first 5G clamshell model in March 2024, significantly bolstered Q1 shipments."

The danger of price cuts

Although bringing foldables up to 5G speed may be a big reason for their growing popularity in China, there's no doubt Chinese manufacturers are trying to drive down the price of these devices, too.

For example, at MWC earlier this year, ZTE launched the Nubia Flip 5G, a clamshell handset priced from £499 – less than half the cost of the Galaxy Z Flip6 (see p73). Motorola's foldables are also cheaper than Samsung's device, with the Razr 50 (see p70) costing £250 less than the Flip6.

Without casting aspersions on either of those devices, Ben Wood fears aggressive price cutting could damage sales in the long term, not boost them. "If we start seeing a flood of cheaper, less resilient foldables with cheaper components, with some corners cut, arriving in the market and they start failing, my worry is that it will be poisoning the well for everybody in foldables," he said.

"If stories start emerging of foldables breaking after six months or three months or whatever – which could happen with these cheaper devices with less expensive hinges and various other things – that could be a real problem for the market leaders who've got more premium and, arguably, very robust devices.

"The challenge for Samsung is the ill-advised actions of rivals taking cost out of the products and making them less durable could have a detrimental impact on the overall market."

“Aggressive price cutting could damage sales in the long term, not boost them”

Gloss comes off big tech jobs

Post-pandemic staff demand more from tech employers

The allure of working for the big tech companies appears to be fading, with research showing growing disgruntlement with conditions inside the top firms.

Big tech firms were once lauded for their huge salaries and tasty perks, such as in-house gourmet dining and pristine gyms. Staff were seemingly willing to accept the trade-offs of long working hours and high-stress environments.

However, the pandemic driving everyone out of those well-equipped offices and back to their homes for extended periods seems to have prompted a widescale re-evaluation of what tech employees regard as important, with in-office perks dropping right down their list of desirables.

Media analytics firm Commetric analysed the employee reviews of ten tech giants – including Google, Microsoft and Apple – sampling 500 reviews from each firm. The research found that those eye-catching benefits were actually less valued by staff than work-life balance, career growth opportunities, working with smart and talented colleagues, and an innovative work environment.

"As our analysis revealed, employees are increasingly dissatisfied with long working hours and high-pressure environments, which contribute to burnout and high turnover rates," said Matthew Couchman, senior consultant at Commetric. "The traditional model of long hours for big rewards is becoming unsustainable. Cool perks and benefits in particular have moved to the bottom of workers' priorities."



ABOVE Employees are starting to value a life-work balance more than in-house perks

Commetric's findings seem to be echoed by Glassdoor, the site on which employees write anonymous reviews of their employers. Big tech firms dominated the top ten list of places to work during the pandemic years, with companies such as Google, Salesforce and Microsoft frequently appearing in the top ten.

This year, however, the only "big tech" firm in the top ten is SAP, with only one other tech company making the list. That contrasts sharply with 2021, at the height of the pandemic, when seven out of the top ten were tech firms, six of them big names.

GLASSDOOR BEST PLACES TO WORK IN UK

	2020	2021	2022	2023	2024
1st	Google	Salesforce	ServiceNow	Bain & Co	Bain & Co
2nd	Equal Experts	Microsoft	AND Digital	ServiceNow	Mastercard
3rd	Salesforce	Abcam	Salesforce	Boston Consulting	Housing 21
4th	Hiscox	Google	Immediate Media Co.	Equinix	Equal Experts
5th	Softcat	Softcat	Abcam	Ocado Tech	Netcompany
6th	Abcam	GTB	McKinsey & Co	Mastercard	Boston Consulting
7th	Microsoft	Apple	Adobe	Google	Airbus
8th	SAP	Bella Italia	VMware	Arup	SAP
9th	Topps Tiles	SAP	Arm	Salesforce	Mott McDonald
10th	Arup	Meta	Meta	Version 1	Gartner

Big tech company Smaller tech company

The dangers of dead domains

There's an enormous market for expired domains. But, as **Barry Collins** discovers, it's not without risks

Peter Askew literally doesn't know his onions. But ten years ago, he bid \$2,200 in an auction for the expired domain **VidaliaOnions.com**, with no clear idea of what to do with it, or even what Vidalia onions were.

In the months that followed, he made contact with Vidalia onion farmers, developed a website from which they could sell their produce directly to consumers, and built a successful online business that's still thriving today, spurred by nothing more than a weird domain name that caught his attention at auction. (You can read his amazing full story at tinyurl.com/36oonions).

Askew's story is a moonshot, a one-in-a-million example of pure entrepreneurship. But buying expired domains – URLs that for one reason or another appear to have been abandoned by their original owner – is far from niche. It's a huge business, with hundreds of thousands of domains being snapped up at auction every day.

But if you're thinking of building your own web business on the back of a dead domain, there are a few potential dangers you should be aware of first.

■ The domain graveyard

You might think that there's not an awful lot of value in domains that people have simply let lapse. You'd be horribly wrong. Where there's muck, there's brass.

At the time of writing, web registrar GoDaddy's expired domain auctions include mypharmacy.com, which is expected to fetch \$15,000; payaccept.com, which is valued at more than \$13,000; and powernews.com, which commands a similar expected price. These aren't fantasy figures, either. The first of those domains had actual bids for well over half the expected amount, with several frantic hours of bidding remaining.

GoDaddy isn't the only company putting expired domains under the hammer. Companies such as Dynadot and Sedo have built huge businesses from selling off expired domains. Most of the big domain registrars have deals with specific auction houses to sell their expired inventory. And there are companies with sophisticated automated bidding systems that are bulk-buying expired domains to add to their portfolios, with the hope of selling them on for a profit.

Digiventures Media Group, which manages a portfolio of domain names, last year released an analysis of all the domain names it had been outbid for at auction. Just under half (47.3%) of these auctions were won by one company,

HugeDomains. "They are the biggest domain name investor and put their money to work, so it's not surprising that they win the most domains," said Andrew Allemann, who has his own portfolio of domain names and who writes about the industry at domainnamewire.com.

Yet, despite the competition from the big beasts, Allemann uses expired domain auctions to boost his own portfolio. "People say 'all of the good domains are taken', and if you believe that, then looking at expired domains is a good way to find domains that were taken years ago that are becoming available again," he said.

■ The Google advantage

The chance to pick up a catchily named .com isn't the only reason people are drawn to expired domain auctions. Buying an expired domain can also give your web business a headstart in the

Domain death rights

Domains can be registered for a period of up to ten years. But if your domains aren't set to auto-renew, they can end up in auctions or be put back in the general pool for anyone to register anew. However, domains aren't normally released the moment the registration expires. Policies vary from registrar to registrar, but they typically work as follows:

1. Expiration

The domain owner fails to renew its registration by the stated expiration date.

2. Grace period

Typically lasting between four to six weeks, the domain enters a grace period where it can still be renewed with the current registrar without incurring any additional fees.

3. Redemption grace period

The domain can still be renewed with your existing registrar, but it will likely involve an extra fee on

RIGHT No flowers please: the demise of a domain name can be a lengthy process

top of the regular renewal fee. This period typically lasts for 30 days.

4. Domain released

If you fail to act by the end of the redemption grace period, the domain will be auctioned off or released back into the general pool. This is colloquially known as "the drop", and there are big companies actively monitoring soon-to-expire domains (so-called drop catchers) who will be ready to pounce if the domain name has any value. Trying to recoup an expired domain at this time could be very expensive.





ABOVE The buying and selling of expired domain names is big business

Google rankings, because that domain might already have several of the factors that the search engine rewards: a long history, incoming links from other websites and a steady flow of web traffic. Indeed, the auction houses will often cite such figures in their domain listings.

However, Allemann warns that such figures should be treated with scepticism. "These stats are most important if you're buying domain names for SEO purposes," he said.

"I think the numbers (especially traffic) can be inflated for various reasons. Before someone spends a lot on a domain name based on this data, it's probably worth looking at a third-party stats provider to verify the numbers."

SEO expert Danny Richman also warns that any Google authority the previous owner of the domain built up can quickly evaporate. "Nobody actually knows for how long Google will maintain the authority on that domain," he said. "But the general received wisdom is that if a domain has been expired for a year, then it probably doesn't really retain any of that value that it had."

There are other reputational risks with buying an expired domain and attaching it to your business. Was the domain previously being abused for a phishing scam, for example? Was it being used to host adult content? Even if it were once a reputable business, did the company burn a lot of goodwill when it went bust, meaning there are scathing online reviews linked to the domain? The Internet Archive's Wayback Machine (web.archive.org) can normally reveal what previously appeared on the domain, but it can be harder to track deeper reputational issues.

The expired domain might also bring unwanted baggage with it. It's not only web traffic that's connected to a domain, but email, too. If you acquire a previously used domain and use it for email addresses, there's a chance you're going to get messages (and spam) intended for the previous holders. "If you've got that domain and you revive the MX records, you could start receiving email," said Stuart Fuller, chief commercial officer at domain name portfolio management firm, Com Laude (comlaude.com). "That could be a huge security risk."

"When anybody sets a domain name to expire, they should be checking the DNS and make sure there's no what we refer to as 'dangling DNS', which would include MX

records," Fuller added. "You should make sure that they are removed before the domain name expires."

■ One previous owner?

If you scour through the lists of expired domain names up for auction, there's a decent proportion that appear to be brand names. The previous owner may have gone out of business or simply have failed to renew the domain, but even if the expired domain is acquired legitimately at auction, it can come back to bite the new owner if it's a registered trademark, for example.

Stuart Fuller says there could be potential legal problems ahead for auction winners that try to exploit a known brand name or pass

themselves off as the domain's previous owner. "They wouldn't have much of a leg to stand on if they originally owned that domain name and they let it expire, and it's been picked up by somebody else," he said. "But what would trump that is if someone was using it in bad faith or was using it to scam people."

Bill Hartzler, CEO of SEO specialist Hartzler Consulting in Texas, agrees there are hidden risks to buying brand-name domains. "Someone buying an expired domain name needs to understand the rights that the former owner of the domain name may still hold," he said. "For example, if the expired domain name contains a trademark, then the buyer runs the risk of having a UDRP [Uniform Domain-Name Dispute-Resolution Policy] filed or lawsuit filed against them." Either of those could see the new owner forfeit the domain.

“ There could be potential legal problems ahead for auction winners that try to exploit a known brand name ”

There's also the risk that the domain you're buying at auction has been stolen from its original owner. Hartzler provides a stolen domain recovery service and says it's not unusual for pilfered domains to end up on auction sites.

"Stolen domain names are a big problem, especially if you rely on

email using your domain name or if you rely on your website to do business," he said. "When your domain name is stolen, you lose access to all emails (the domain thief then has access to the emails), and your website will go down in most cases."

"Some stolen domain names end up at a domain auction or they are listed for sale on aftermarket platforms," he added. "Sometimes they are sold to someone else who is not aware that they're buying a stolen domain name. In other cases, the owner of the domain name is not aware the name was sold until they lose access to the domain name (such as losing access to email or the website goes down)."

So, whether you want to be the next big thing in boutique shallots or another previously owned URL catches your eye, you could get a handy step up the ladder for a modest outlay by picking up an expired domain name. But don't assume that just because the domain appeared dead, it won't come back to haunt you.

The A-List



The best products on the market, as picked by our editors

PREMIUM LAPTOPS

Apple MacBook Pro 16in (2023)

M3 power from £1,699
from apple.com

The M3 chips give the already brilliant MacBook Pro series a boost in games with no sacrifices elsewhere, so power users who are happy with Apple must grapple with the big decisions: which M3 chip, which size of screen, and how much RAM and storage?

REVIEW Issue 352, p46



ALTERNATIVES

Apple Mac Book Air 13in (M3)

Both the 13in and 15in MacBook Airs impress for speed, styling and battery life, but the 1.2kg 13in Air wins out of the two for its sheer portability. **From £1,299** from apple.com

REVIEW Issue 356, p54

Huawei MateBook X Pro (2024)

Despite weighing just 980g, this laptop packs a 14.2in OLED panel, 2TB of storage and an 11-hour battery life, as well as an Intel Core Ultra 9 processor. **£2,100** from consumer.huawei.com

REVIEW Issue 358, p60

Asus Vivobook Pro 15 OLED (2024)

A mobile workstation disguised as a slim laptop, the Core i9/RTX 4060 combo provides a staggering amount of power in its high-quality, 1.8kg frame. **£1,600** from uk.store.asus.com

REVIEW Issue 357, p60

BUSINESS LAPTOPS

NEW ENTRY

Lenovo ThinkPad T14s Gen 6 (Snapdragon)

Copilot+ PC for £1,500 exc VAT
from lenovo.com

It's perhaps a controversial choice – and we wouldn't roll this out en masse – but if you're buying for executives or CTOs this cutting-edge Copilot+ PC, complete with a Qualcomm Snapdragon Arm processor, is a superb choice. Not only is it good value, it's light, it's fast and its all-day battery life is genuinely 24 hours.

REVIEW Issue 360, p56



Lenovo ThinkPad X1 Carbon Gen 12

The X1 Carbon range has stepped up a gear thanks to Intel's Core Ultra chips, and Lenovo matches it with the stunning build quality and keyboard you'd expect. **From £1,375** from lenovo.com

REVIEW Issue 358, p58

Acer TravelMate P6 (TMP614-53)

The all-new TravelMate P6 benefits from a 14in OLED screen with a 2,880 x 1,800 resolution, plus a very generous spec for the price. It's simply great value. **£1,209 exc VAT** from acer.co.uk

REVIEW Issue 350, p80

HP Dragonfly G4

It's not the fastest machine you can buy, but otherwise this 1kg masterpiece is as close as you're going to get to the perfect business laptop for executives. **From £1,380 exc VAT** from hp.com

REVIEW Issue 352, p58

GAMING LAPTOPS

Razer Blade 16 (2024)

Power and panache, from £3,000
from razer.com

The Blade 16 offers a sumptuous OLED screen, bags of connectivity and astonishing levels of performance – particularly with the RTX 4090 in place. If you're in the market for a powerful 16in laptop that will eat up games and creative applications, this is the one to go for.

REVIEW Issue 359, p60



ALTERNATIVES

Lenovo Legion 9i Gen 8 (16in Intel)

The liquid-cooling system may be only for bragging rights, but this slim laptop delivers the goods with a superb 16in mini-LED screen. **RTX 4090, £4,180 inc VAT** from lenovo.com

REVIEW Issue 353, p58

HP Omen Transcend 14

This compact, stylish 14in OLED gaming laptop packs a punch thanks to its RTX 4060 graphics. **Part code, 9R292EA#ABU. £1,799** from hp.com/uk

REVIEW Issue 357, p54

Asus ROG Zephyrus G14 (2024)

This sleek 1.5kg laptop can take RTX 4070 cards to deliver triple-figure frame rates on its 120Hz 14in OLED screen. **From £2,400** from rog.asus.com

REVIEW Issue 356, p58

EVERYDAY LAPTOPS

Acer Aspire 14 A14-51GM

Compact power for £850
from acer.com

Want gaming power? Buy the version with RTX 2050 graphics for £850 (part code NX.KSVEK.005). Just care about value? Get a Core 5 processor and integrated graphics for £600 (part code NX.KRWEK.00B). Whichever you choose, it's a staggering laptop for the price.

REVIEW Issue 359, p82



NEW ENTRY

Asus Zenbook 14 OLED (UX3405)

If you can stretch past £1,000, this is a top-quality Core Ultra laptop with a superb 120Hz screen and great battery life. **From £1,099** from uk.store.asus.com

REVIEW Issue 359, p58

Framework Laptop 13 (DIY Edition)

With a competitive price, modular approach and easy-to-repair ethos, you can pick and mix your perfect 13in laptop. **From £779** from frame.work

REVIEW Issue 360, p58

Huawei MateBook D16

It's big and certainly not bashful, packing an Intel Core i9 chip and a high-quality 16in panel – and surprisingly good battery life, too. **£1,000** from huawei.com

REVIEW Issue 359, p87

CHROMEBOOKS

Acer Chromebook Spin 714

Flipping great for £799

from [currys.co.uk](https://www.currys.co.uk)

Simply the best Chromebook around. Others may beat the 12th gen Intel Core i5 we tested for performance, but for features, design and bang for buck you won't find any laptop that can match this convertible for £799.

REVIEW Issue 356, p83



Acer Chromebook Plus 515

This Chromebook Plus laptop is all about value. With strong speeds thanks to Intel's Core i5-1235U processor, and a good-quality 15.6in panel with a 1,920 x 1,080 resolution, Asus' Chromebook Plus 515 is ideal for families, students and business users, providing mobility isn't your main priority as it isn't particularly light at 1.7kg. **£429 from [currys.co.uk](https://www.currys.co.uk)**

REVIEW Issue 356, p82

Lenovo IdeaPad 5i Gaming Chromebook Plus

The 120Hz 15.6in display is the star of this Chromebook, as it should be with 2,560 x 1,600 pixels to play with. You're getting a lot of laptop for the price, too, including a 512GB SSD, Core i5-1235U processor and 8GB of RAM. Just note the 1.9kg weight.

£659 from [very.co.uk](https://www.very.co.uk)

REVIEW Issue 356, p88

EVERYDAY PCs

Apple Mac mini (2023)

M2 masterpiece from £649

from [apple.com](https://www.apple.com)

The outside remains the same, but this simple yet effective update to the Mac mini introduces the M2 and M2 Pro processors with predictable effect. The entry-level price quickly rises once you start upgrading – moving from 8GB to 16GB costs £200, as does doubling the base storage from 256GB to 512GB – but there's enough power here to last you for years.

REVIEW Issue 343, p60



Geekom A8 Mini PC

Geekom makes brilliant use of AMD's Ryzen 9 8945HS in this powerful mini PC, which occupies little more desktop space than a drinks coaster. And it still packs every port most people need, plus Wi-Fi 6E. If you don't need this much power (or 32GB of RAM and a 2TB SSD) the Ryzen 7 version is £719.

Ryzen 9, £899 from [geekom.co.uk](https://www.geekom.co.uk)

REVIEW Issue 359, p62

PCSpecialist Fusion Elite P

A promising debut for AMD's Ryzen 8600G processor, this quiet-running, power-efficient system packs in lots of performance considering it costs so little. And a slot sits empty for a future graphics card upgrade should the built-in graphics prove insufficient for your gaming needs. **£649 from [pcspecialist.co.uk/reviews](https://www.pcspecialist.co.uk/reviews)**

REVIEW Issue 355, p54

ENTHUSIAST PCs

NEW ENTRY

NEW ENTRY

CyberPowerPC Ultra R77 RTX Gaming PC

RTX Super 4080 power for £2,275

from [tinyurl.com/356cyber](https://www.tinyurl.com/356cyber)

The striking case catches the eye, but it's the potency of AMD's Ryzen 7 7800X3D and Nvidia's RTX 4080 Super graphics that leave the lasting effect.

REVIEW Issue 356, p62



CyberPowerPC Infinity X145 Elite

Designed to deliver the maximum possible gaming power for £999, this Core i5-14400F system – with 32GB of DDR5 RAM and GeForce RTX 4060 graphics – is a great machine now with potential for more later. **£999 from [tinyurl.com/360cyber](https://www.tinyurl.com/360cyber)**

REVIEW Issue 360, p61

Palicomp AMD Destiny

Palicomp builds an incredibly fast gaming PC for the money thanks to the wicked combination of AMD's Ryzen 7 7800X3D and Nvidia's GeForce RTX 4070 Super. With a fast 1TB SSD and 32GB of RAM in support, it's enough for smooth 4K gaming. **£1,249 from [palicomp.co.uk/desire-mag1](https://www.palicomp.co.uk/desire-mag1)**

REVIEW Issue 360, p60

ALL-IN-ONE PCs

HP Envy 34 All-in-One

£2,099 widescreen wonder

from [hp.com](https://www.hp.com)

Built around a high-quality 34in widescreen – which is perfect for viewing two windows side by side thanks to its 21:9 aspect ratio – this also comes with Nvidia RTX 3060 graphics. We're big fans of the magnetic 16-megapixel camera, too.

REVIEW Issue 335, p46



Dell Inspiron 24 All-in-One

Despite being built to hit a price point, the Inspiron 24 All-in-One manages to look classy, include a good-quality, 1,920 x 1,080 24in panel and have enough power to breeze through a typical day's tasks. It even packs mod cons such as a 720p webcam. Superb value for money.

From £599 from [dell.co.uk](https://www.dell.co.uk)

REVIEW Issue 350, p47

Apple iMac 24in (M3)

The iconic design remains the same, but the plain M3 chip inside the revamped iMac 24in is a revelation compared to the previous M1 version. The downside is that the base configuration includes a stingy 8GB of memory and a 256GB SSD.

From £1,399 from [apple.com](https://www.apple.com)

REVIEW Issue 352, p52

CREATIVE WORKSTATIONS

Scan 3XS GWP TR Ada

Record breaker for £14,167 exc VAT

from [scan.co.uk](https://www.scan.co.uk)

A 64-core Ryzen Threadripper 7980X blows everything that went before out of the water with multithreaded tasks, while Nvidia's RTX 6000 Ada graphics dominates for viewport acceleration and GPU rendering. Even storage throughput is unparalleled. With a striking chassis and brilliant build quality, you'll want for nothing.

REVIEW Issue 353, p52



Armari Magnetar MC16R7

A strikingly fast workstation for the money, with Armari's customised liquid cooling extracting the most from an AMD Ryzen 9 7950X. With 64GB of DDR5 RAM and AMD's Radeon Pro W7800 in support, this is a fantastic value machine.

£3,758 exc VAT from [armari.com](https://www.armari.com)

REVIEW Issue 348, p84

PCSpecialist Onyx Pro

Even in a creative workstation, it makes a lot of sense to include Nvidia's consumer graphics due to its core-per-buck. Here, an Nvidia RTX 4090 partners with a Core i9-13900K and an incredible 192GB of RAM to tremendous effect. **£3,750 exc VAT from [pcspecialist.co.uk/reviews](https://www.pcspecialist.co.uk/reviews)**

REVIEW Issue 348, p86



TABLETS

Apple iPad Air (M2)

M2 power from £599
from apple.com

We love the new iPad Pro, but for most people the M2 iPad Air is not only far better value but also all the tablet they'll need. It supports the Magic Keyboard and Pencil Pro, plus it's now available in both 11in and 13in sizes.

REVIEW Issue 358, p50



Apple iPad Pro (M4)

The best tablet in the world becomes even better thanks to Apple's stunning M4 chip, a gorgeous OLED screen and the must-have accessory: the all-new Pencil Pro. But it comes with an obvious downside of cost, with the cheapest 13in incarnation costing £1,299. **From £999 (11in, 256GB) from**

apple.com
REVIEW Issue 358, p48

OnePlus Pad

The OnePlus fully justified its place in our luxury tablet Labs thanks to its outstanding build quality, slick performance and stunning 17-hour battery life. It's the best Android option outside of Samsung's Galaxy Tabs – and it won't do nearly so much damage to your wallet.

£449 from oneplus.com
REVIEW Issue 352, p86

EVERYDAY PHONES

Motorola Moto G54 5G

Great looker for £180
from johnlewis.com

The 6.5in 120Hz IPS display is the G54's standout feature, but it improves on the previous generation in numerous ways while being even cheaper. It's faster, looks better, takes great photos and battery life is strong. You won't find better for less than £200.

REVIEW Issue 355, p77



Google Pixel 8a

We're fans of the Pixel 8 but you can save £200 and buy the 8a without missing out on any key features, including its advanced AI skills thanks to the same Tensor G3 chip inside. It's only when you zoom into snaps that you spot the camera quality difference.

128GB, £499 from store.google.com
REVIEW Issue 358, p74

Samsung Galaxy A55

Not the fastest phone on the market, but in return you get a high-quality 6.6in OLED display, excellent battery life and a trio of strong cameras. And you also get four years of feature updates. With a price that significantly undercuts the Pixel 8a, it's great value, too.

128GB, £364 from johnlewis.com
REVIEW Issue 358, p77

PREMIUM PHONES

NEW ENTRY

Samsung Galaxy S24 Ultra

AI cleverness from £1,249
from samsung.com

The undeniably high price gets you a bunch of AI tools that will genuinely save you time (and money). While we miss the 10x optical zoom of the S23 Ultra, the 5x zoom camera and supporting cast capture brilliant images, while the S Pen is always on hand to scrawl notes and pictures.

REVIEW Issue 354, p58



Google Pixel 8

It's not a huge step up from the Pixel 7, but the added AI features are genuinely useful and it benefits from a handful of upgrades, too – including a 120Hz screen and the new Tensor G3 processor. If you don't mind the lack of optical zoom, it's a great buy for the price.

128GB, £699 from store.google.com
REVIEW Issue 351, p72

Motorola Razr 50 Ultra

Not merely a huge upgrade over last year's Razr 40 Ultra, this new model also leapfrogs over Samsung's new Flip6 to become our flip phone of choice. That's thanks to its great battery life, superb screens (particularly on the outside) and a camera that's a joy to use.

£1,000 from motorola.co.uk
REVIEW Issue 360, p88

EVERYDAY MONITORS

NEW ENTRY

Iiyama ProLite XUB3293UHSN-B5

32in 4K bargain, £429
from currys.co.uk

The fact that this 31.5in IPS monitor could compete so well against Eizo's alternative (see below) says it all. Great colour coverage in sRGB and DCI-P3, USB-C and RJ45 inputs, plus solid build quality add up to a bargain.

REVIEW Issue 357, p88



AOC Q27B3CF2

AOC's relentless focus on value delivers a 27in 1440p screen with a high-quality IPS panel that costs £200 including VAT – and also packs in a USB-C port. Those are almost the only features you get, and the OSD is awful, but at this price we're not complaining.

£200 from amazon.co.uk
REVIEW Issue 360, p77

Acer Verso B277 Ebmiprxv

This is a basic but high-quality monitor, delivering colourful images across its 27in Full HD diagonal. You don't get USB-C docking, but it includes VGA, HDMI and DisplayPort inputs, plus a two-port USB hub.

£149 from tinyurl.com/357acer277
REVIEW Issue 357, p84

PROFESSIONAL MONITORS

Eizo FlexScan EV3240X

Stunning 4K quality, £1,206
exc VAT from photospecialist.co.uk

With images that whack you between the eyes as soon as you lift it, fully assembled, from its box, this 32in 4K monitor is our top choice pick for anyone willing to make such a hefty long-term investment.

REVIEW Issue 357, p91



Eizo ColorEdge CG2700X

A brilliant choice for professional designers, whether working solo or in teams, thanks to its dedication to providing accurate colours across potentially years of life. It's also bang up to date for connectivity, with USB-C and RJ45 making it easy to manage, too.

£2,149 exc VAT from wexphotovideo.com
REVIEW Issue 357, p90

BenQ PD2706U

If you can't stretch to Eizo budget levels then this 4K 27in screen is definitely worth investigating. It has several features aimed at professionals, including a Hotkey Puck to switch between profiles, plus great coverage of the sRGB and DCI-P3 gamuts.

£333 exc VAT from scan.co.uk
REVIEW Issue 357, p86

WEBCAMS

NEW ENTRY

Logitech MX Brio 705 for Business

Consistent brilliance for £219

from [logitech.com](https://www.logitech.com)

Consistent image quality in all lighting conditions coupled with top build quality and nifty features – such as a presenting mode for items on your desk – make this a fantastic all-round choice.

REVIEW Issue 356, p68

Logitech Brio 105 for Business

While you can buy 1080p webcams for a third of the Brio 105's price, they won't hold a candle to the Logitech webcam's quality – especially in low-light conditions, such as one candle. It's also easy to manage, for businesses and individuals.

£45 from [logitech.com](https://www.logitech.com)
REVIEW Issue 360, p77

Obsbot Tiny 2

This portable 4K webcam delivers for quality, design and sharpness, and it comes with a shedload of advanced features, including dynamic zoom and subject tracking. The only real downside is that it has a price that reflects its premium ambitions.

£329 from [amazon.co.uk](https://www.amazon.co.uk)
REVIEW Issue 352, p75

HOME OFFICE PRINTERS

Epson EcoTank ET-2830

Ink tank all-in-one for £250

from [epson.co.uk](https://www.epson.co.uk)

Don't expect flashy features, but do expect fast print speeds, high-quality prints, scans and copies, plus phenomenally low running costs – even after you've exhausted the 6,000 pages' worth of bottled ink that comes with it.

REVIEW Issue 353, p85

Canon Pixma TS8750

A fantastic choice for creative users that's equally at home printing photos as it is scanning artwork. Despite its high running costs, due to its reliance on cartridges, this is a superb all-in-one.

£159 from [printerbase.co.uk](https://www.printerbase.co.uk)
REVIEW Issue 353, p86

HP OfficeJet Pro 9012e

So long as your print volumes aren't huge – the running costs mount up – this is a superb all-in-one for home office usage. It's fast, robust, prints double-sided and produces strong all-round results.

£208 from [printerland.co.uk](https://www.printerland.co.uk)
REVIEW Issue 353, p87

WORKGROUP PRINTERS

Canon Maxify GX6550

Ink tank all-in-one for £392 exc VAT

from [canon.co.uk](https://www.canon.co.uk)

Designed to fit in tight spaces, this all-in-one includes a highly effective ADF and backs it up with high-quality prints at 24ipm in our tests. Running costs are superb, too.

REVIEW Issue 350, p58

Brother HL-L9430CDN

This laser printer (not an all-in-one, so there's no scanning or copying functionality) is a great choice for a busy office, producing sharp black text and making a good job of colour graphics as well. All while doing so quickly with a competitive price per page.

£415 exc VAT from [printerland.co.uk](https://www.printerland.co.uk)
REVIEW Issue 353, p84

Xerox B315DN

A fine alternative to the Brother and Canon, this mono laser multifunction printer produces superb results at great speed – 27.5 pages per minute in our 50-page test, which includes the spool time. It's similarly quick for scans, with a dual-CIS ADF to speed up double-sided copies.

£238 exc VAT from [printerbase.co.uk](https://www.printerbase.co.uk)
REVIEW Issue 341, p87

WIRELESS ROUTERS

Netgear Nighthawk RAXE300

Fast Wi-Fi 6E router, £350

from [amazon.co.uk](https://www.amazon.co.uk)

The RAXE500 is faster than the RAXE300, but in practice we doubt you would notice – this tri-band router still delivered speeds between 50MB/sec and 150MB/sec in our tests. And it's packed with features, too. At £150 cheaper than its bigger brother, we think it hits the Wi-Fi 6E sweet spot.

REVIEW Issue 341, p68

Netgear Nighthawk RS700S

Make no mistake – you won't get stunning speeds out of this Wi-Fi 7 router today. But if you must buy a router now and want future-proofing, this is a solid choice. But honestly, we would recommend that you wait.

£800 from [netgear.com](https://www.netgear.com)
REVIEW Issue 353, p76

Asus RT-AX59U

You can buy cheaper Wi-Fi 6 routers – such as the D-Link Eagle Pro AI R15 for £55 – but Asus' well-priced offering delivers strong performance along with lots of control and exceptional VPN support.

£125 from [uk.store.asus.com](https://www.uk.store.asus.com)
REVIEW Issue 350, p57

MESH WI-FI

TP-Link Deco XE200

Clever Wi-Fi 6E for £600

from [amazon.co.uk](https://www.amazon.co.uk)

There are cheaper Wi-Fi 6E meshes, but the XE200 wins for its superb download speeds, excellent coverage and the fact that older clients reap benefits of 6E, not just new ones. And a two-pack (code BOBKTDPCW8) should be enough for most premises.

REVIEW Issue 349, p65

Mercusys Halo H80X

A new subsidiary of TP-Link, Mercusys offers its parent brand's XE75 router some excellent value-for-money competition. Not as fast due to Wi-Fi 6 rather than Wi-Fi 6E, but it has all the bandwidth you need for everyday use and should deliver it stably throughout your house. There are plenty of features too.

2-pack, £161 from [ebuyer.com](https://www.ebuyer.com)
REVIEW Issue 341, p71

Linksys Velop Pro 6E

Ironically, this Wi-Fi 6E router will get the most out of your non-Wi-Fi 6 devices thanks to its use of the 6GHz network for station-to-station traffic. And you only need two units for rock solid performance across a three-bedroom house.

2-pack, £380 from [amazon.co.uk](https://www.amazon.co.uk)
REVIEW Issue 350, p54



BUSINESS WI-FI

NEW ENTRY

Zyxel WAX640S-6E Wi-Fi 6E AP, £369 exc VAT

from broadbandbuyer.com

A nicely priced tri-band wireless access point ideally suited to businesses that want to provide the full range of wireless services. It's easy to deploy, wireless performance is good and Zyxel provides top-quality cloud management services.

REVIEW Issue 353, p100



TP-Link Omada EAP783

This slim-line discus has a mighty BE19000 rating and will appeal to businesses looking to make an early transition to Wi-Fi 7. It delivers superb performance and is MLO-ready, while TP-Link's Omada cloud platform offers great remote management services.

£520 exc VAT from senetic.co.uk

REVIEW Issue 360, p103

Ruijie Reyee RG-RAP2260(E)

This competitively priced Wi-Fi 6 AP delivers business-class features and impressive performance, and the free Ruijie Cloud service offers a wide range of remote network management and monitoring tools.

£160 exc VAT from broadbandbuyer.com

REVIEW Issue 359, p103

NAS SERVERS

Synology DiskStation DS1823xs+

10GbE NAS, £1,413 exc VAT

from broadbandbuyer.com

This powerful eight-bay NAS is a great choice for SMBs that want plenty of capacity, features and performance at a reasonable price. The new DSM 7.2 software has security high on its agenda, and the icing on the cake is Synology's generous five-year warranty.

REVIEW Issue 346, p101



Qnap TS-h987XU-RP

The TS-h987XU-RP is a ready-made hybrid storage solution for SMBs.

This rack-friendly package offers a great specification for the price, and Qnap's QuTS hero software scores highly for its wealth of data-protection features and business apps.

Diskless, £3,292 exc VAT from broadbandbuyer.com

REVIEW Issue 344, p96

Synology DiskStation DS1522+

Small businesses that want a high-capacity desktop NAS at a good price will find Synology's DS1522+ a great choice. Performance over 10GbE is impeccable and the DSM software offers a fantastic range of storage features.

5-bay NAS, diskless £586 exc VAT from broadbandbuyer.com

REVIEW Issue 344, p98

VIDEOCONFERENCING

NEW ENTRY

Owl Labs Meeting Owl 4+ Magical meetings, £1,665 exc VAT

from owllabs.co.uk

For fully immersive meetings, nobody does it better than Owl Labs. The Owl 4+ sports a new 64MP fish-eye camera that boosts video output to 4K Ultra HD while keeping super-smooth speaker tracking. Pairing it with an Owl Bar covers every meeting room angle.

REVIEW Issue 360, p102



Poly Studio X52 with TC10

Ideal for businesses that want a professional videoconferencing solution for medium-sized meeting rooms. Video quality is excellent, speaker tracking is exceptionally fast, and the big choice of built-in VC apps makes it incredibly versatile too.

£3,161 exc VAT from meetingstore.co.uk

REVIEW Issue 353, p102

Jabra PanaCast 50

This sleek cylinder delivers great video and audio quality, fast speaker tracking and a wealth of advanced features. Jabra's Xpress web portal offers smart remote management services, and the super-wide view helps make the PanaCast 50 ideal for all-inclusive meetings.

£867 exc VAT from uk.insight.com

REVIEW Issue 354, p100

SCANNERS

Xerox N60w Pro Scanner

Speed demon, £766 exc VAT

from tradescanners.com

The N60w Pro offers tremendous value and versatility. It delivered up to 67ppm in our tests with great output quality, offers a plethora of connection options and makes walk-up scanning a breeze.

REVIEW Issue 358, p101



Brother ADS-4500W

Ideal for small businesses, the ADS-4500W offers a fine set of walk-up scan features and its output quality is beyond reproach, while Brother's Print&Scan app delivers great scan workflow management options.

£295 exc VAT from printerbase.co.uk

REVIEW Issue 358, p98

Epson WorkForce ES-C320W

A space-saving wireless desktop scanner, the Epson WorkForce ES-C320W delivers nippy speeds – around 31ppm in our tests – and is backed with software that offers plenty of scan management features.

£180 exc VAT from printerland.co.uk

REVIEW Issue 358, p100

SERVERS

Dell EMC PowerEdge T350

Xeon E-2300 power, from £1,399 exc VAT

from dell.com

Perfect for SMBs and branch offices looking for an affordable and powerful single-socket tower server. Along with support for Xeon E-2300 CPUs and lots of memory, it has a high storage capacity, plenty of expansion space and is sturdily built.

REVIEW Issue 335, p98



Dell EMC PowerEdge R250

With prices starting at around £850 exc VAT for a Pentium Gold CPU, and the option of Xeon E-2300 series chips from £1,461 exc VAT, this is a slim, rack-mounted alternative to the more high-powered T350 that's ideal for SMBs.

From £845 exc VAT from dell.com

REVIEW Issue 332, p98

Broadberry CyberServe Xeon E-RS100-E10

This represents a powerful hardware package at a price that will please small businesses. We love its low-profile chassis and the fine selection of remote-management tools. It's a great alternative to the Dell EMC servers also listed here.

£983 exc VAT from broadberry.co.uk

REVIEW Issue 318, p96

SECURITY SOFTWARE

Avast Ultimate

Buy from retail and this is a bargain, with a solid VPN, anti-tracking software and handy detection fees on top of excellent protection. **10 devices, 2yrs, £30 from store.pcpco.co.uk**
REVIEW Issue 355, p84



G Data Total Protection

G Data provides straightforward, effective and inexpensive protection against malware and other threats to your system, making it a favourite despite its quirks. **5 devices, \$82 from gdatasoftware.co.uk**
REVIEW Issue 355, p87

Avast One Essential

Avast One Essential has the same malware-detection engine as our top choice, but for free. It even includes 5GB of VPN services per month and a few system optimisation tools. **Free from avast.com**
REVIEW Issue 355, p89

VPNs

Surfshark

Reliably fast and goes out of its way to ensure that international streaming services work. Surfshark has a credible track record for privacy, too. **£55 for 27 months from surfshark.com**
REVIEW Issue 360, p87



Surfshark

NEW ENTRY

NordVPN

One of the best all-purpose consumer VPN services around, and the paid-for version is packed with features – from anti-malware tools to a rather clever mesh file-transfer system. **£94 for 27 months from nordvpn.com**
REVIEW Issue 360, p85

NEW ENTRY

Proton VPN

A great VPN in its own right, but also the best free VPN service as you get unlimited data. Instead, Proton restricts which endpoints you can access to only three countries: the USA, the Netherlands and Japan. **Free from protonvpn.com**
REVIEW Issue 360, p86

PASSWORD MANAGERS

NordPass

This hassle-free option is a great choice for both personal and business use, with a competitive price matched with all the features most people need. **£1.89 per month from nordpass.com**
REVIEW Issue 350, p70



NordPass

Bitwarden

Free for individual use and open source, the only important thing Bitwarden lacks is phone support: it works with virtually every device and browser, and the paid option is well worth £10 per year. **Free from bitwarden.com**
REVIEW Issue 350, p71

Keeper

A great choice for businesses thanks to its focus on security and a zero-knowledge policy, and if you need more options then Keeper has them. **Business edition, from £2 per user per month from keepersecurity.com**
REVIEW Issue 350, p72

ENDPOINT PROTECTION

Sophos Intercept X Advanced

Delivers a huge range of endpoint protection measures for the price. It's simple to deploy, device and user policies add flexibility, and seamless integration with the Sophos Central cloud portal makes management simple. **500-999 users, 1 year, £36.50 each exc VAT from enterpriseav.co.uk**
REVIEW Issue 351, p98



CLOUD BACKUP

IDrive Business

A top cloud backup choice for SMBs that want to protect on-premises systems and remote workers. Platform and business app support is outstanding, it's easy to use and the simple capacity-based subscriptions are incredibly good value. **5TB, £838 exc VAT per year from idrive.com**
REVIEW Issue 359, p101



VOIP SERVICES

3CX Phone System V20

Our top choice for businesses that want to manage their own VoIP system. It can be hosted in the cloud or on-premises, and has lots of new features. **Small Business, 10 users, £175 exc VAT per year from 3cx.com**
REVIEW Issue 357, p98



WithSecure Elements EPP and EDR

High levels of automation make WithSecure a great choice for SMBs that want endpoint protection on a plate. It's easily managed from the cloud, too. **100-499 devices, £37 each per year exc VAT from withsecure.com**
REVIEW Issue 351, p99

Acronis Cyber Protect 16 Advanced

Flexible subscriptions keep costs under control, the EDR service stays one step ahead of cybercriminals and it's easy to manage, too. **From £95 exc VAT per year from acronis.com**
REVIEW Issue 359, p98

TelephoneSystems.Cloud

A great choice for businesses that know what they want from cloud-hosted VoIP services, offering a wealth of features at a competitive price. **From £11 exc VAT per user per month from telephonesystems.cloud**
REVIEW Issue 357, p100

NETWORK MONITORING

Progress WhatsUp Gold 2023.1

Simple to deploy and offers an impressive range of network-monitoring tools. The choice of licensing plans makes it an affordable option for SMBs, and support teams will love its smart dashboard and NOC views. **Enterprise, 50 devices, £1,192 exc VAT per year from whatsupgold.com**
REVIEW Issue 354, p99



REMOTE SUPPORT

IDrive RemotePC Team

IDrive's RemotePC Team will appeal to SMBs that want affordable cloud-hosted remote support for their offices and home workers. It's exceedingly simple to deploy, easy to manage and delivers tough access security measures. **First year, 50 computers, £172 exc VAT from remotepc.com**
REVIEW Issue 349, p98



NetSupport Manager 14

Delivers a wealth of support tools, including secure access to home workers, and licensing plans are good value. **1-500 systems, perpetual licence, £10 each exc VAT from netsupportmanager.com**
REVIEW Issue 349, p100

SECURITY APPLIANCES

NEW ENTRY

DrayTek Vigor 2927Lax-5G

SMBs and remote offices that demand always-on internet access will love this affordable security router. It offers an unbeatable set of WAN redundancy features and adds extra value with its built-in Wi-Fi 6 services. **£667 exc VAT from broadbandbuyer.com**
REVIEW Issue 360, p98



NEW ENTRY

WatchGuard Firebox M390

Combines strong performance with an incredible range of security measures all at a competitive price. **Appliance with 1yr TSS subscription, £4,273 exc VAT from broadbandbuyer.com**
REVIEW Issue 360, p100



Circling back to the beginning



Dick Pountain is editorial fellow of *PC Pro* and quite satisfied with his slice of the π . He has indeed been writing for the magazine since its beginning in 1994. Email dick@dickpountain.co.uk

In this thoroughly irrational column, discover the root of one man's lifelong obsession with maths – and accidental side-route into computers

Astute readers `<aside class="smarm"> which of course to me means all of you </aside>` will have noticed that this is the 30th anniversary issue of *PC Pro*, and since this is a monthly magazine, and since there are 12 months in a year, and since this is my 360th opinion column, the corollary is that I've been writing here since the beginning. I use the word "corollary" there because it suggests a mathematical proof, and that is a ham-fisted way of introducing my theme for this month, which is mathematics.

360 is a special number not simply because it represents 30 years, but because when expressed as an angle in degrees it represents a full circle, a return to the beginning. Another way to look at a full circle is in radians as an angle of 2π , which I find more congenial because π is an irrational, even transcendental, number and I like to think of this column as being sometimes irrational and occasionally even transcendental (which you astute readers may also have noticed).

What I'm tiptoeing around here (in this nauseatingly arch manner) is a confession, namely that I'm only posing as a computer nerd; I'm actually a mathematician *manqué*, a math sheep in hacker/wolf's clothing. At school, way back in the early 1960s, maths was my top subject, in which I got a distinction at S Level. I had to choose between reading chemistry or maths at uni, but was seduced into the former by the lure of stinks and bangs over pencil and paper. My introduction to computing came very early, in 1962, as part of a school team that built a prize-winning computer

out of ex-RAF radar set parts, but that computer was analog, not digital, and all it could do was solve sixth-order differential equations and display the result as green squiggles on a cathode ray tube (which only real maths nerds could appreciate).

Math-nerdship never left me even once I discovered "real" digital computers. At college I only used London University's Atlas to process the statistics for my biochemistry experiments. After Dennis Publishing (or H Bunch Associates as we were called then) bought *Personal Computer World* in 1979, as the only maths nerd in the room I was delegated to take home a Commodore PET and learn how to program. I discovered that I loved it, but math-nerdship continued to steer my journey because after BASIC I learned Pascal, Forth and Lisp, rather than C, which would have been the obvious choice were I to want to make a living from coding (which I didn't and don't).

Elsewhere in this issue you'll find our nominations for the most important milestones in computing over the past 30 years, so rather than recap those here I'll instead name a few of my favourite milestones in computer-related math-nerdship. Thanks to the internet everything is computer-related now, so I follow developments in maths through YouTube videos, Wikipedia articles, Royal Institution and TED talks, but most of all through the excellent, non-profit, Pulitzer-Prize-winning *Quanta Magazine*.

Launched in 2012 to promote public understanding of mathematics, theoretical physics, theoretical computer science and the basic life sciences, *Quanta* is funded by, but editorially independent of, the Simons Foundation. James Simons

“The great thing about maths is that it doesn't require a lot of apparatus, just a brain plus some sand and a stick, or a pencil and paper”

is a mathematician, educated at MIT and Berkeley, who started out working on pattern recognition, string and quantum field theory, then went to Wall Street and used his maths as a “quant” investor to become the 51st richest person in the world.

My favourite recent *Quanta* pieces have been by Philip Ball on “The New Math of How Large-Scale Order Emerges” (tinyurl.com/360newmath) and one on Dedekind (tinyurl.com/360Dedekind). Number theory is the part of maths that still entrances me; irrational and transcendental numbers such as π have infinitely many, non-repeating digits after their decimal point, which makes them a little awkward to handle. Dedekind found a stunningly elegant way to pin them down, by splitting the number line into everything below and everything above the one you want.

I still write programs – in QPython on my Chromebook – but nowadays they're almost always about maths, playing with palindromic numbers or fiddling hopelessly with the Collatz conjecture. I watch tons of YouTube videos that use clever visualisation tricks to explain p-adic numbers and their relation to the Riemann hypothesis. The great thing about maths is that it doesn't require a lot of apparatus, just a brain plus some sand and a stick, chalk and a blackboard or a pencil and paper (or Python and a Chromebook). And there's always a chance of being that amateur who makes a significant discovery.

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“I'm only posing as a computer nerd; I'm actually a math sheep in hacker/wolf's clothing”

Generative AI has serious costs – it's time to be useful



Nicole Kobie is *PC Pro's* Futures editor. She would be very happy if ChatGPT could help reduce her energy bill. And her mortgage, while y'all are at it.
X@njkobie

Every time we exploit a large language model we chew through a chunk of power, so now the suppliers need to prove they're worth it

Generative AI is energy hungry. Training the ever-growing models requires more data centres – and more powerful ones at that. That means the AI arms race could have serious repercussions.

Google has admitted that its emissions have climbed 48% over the past five years, pinning the blame on electricity consumption from data centres as well as its wider supply chain. As a result, its AI investments made it difficult to predict when it would reach net zero. Microsoft president Brad Smith now says the company's own carbon-negative "moonshot" is unlikely to be reached any time soon, as "the moon has moved" because of AI. Now repeat this pattern across all the many companies developing generative AI.

But don't worry, says Microsoft founder Bill Gates: AI will fix it for us. "Let's not go overboard on this," he said. "Data centres are, in the most extreme case, a 6% addition [in energy demand] but probably only 2% to 2.5%. The question is, will AI accelerate a more than 6% reduction? And the answer is: certainly."

“If AI can help, how about we use it now to fix real problems, and then we do the silly stuff?”

Oh, good. But when, Bill? Because when it comes to the climate crisis, timing matters.

If AI can help, as Gates believes, how about we use it *now* to fix real problems, and *then* we do the silly stuff? Let's prioritise AI systems – even if they're not trendy LLMs – that can reduce energy use, assist with climate change prevention and mitigation, and improve renewable energy systems.

And that's all possible, as AI as a wider technology has already made

valuable contributions to us humans: spotting disease, unpicking scientific quandaries and even modelling climate change. But when it comes to generative AI and the LLMs that power such systems, rather than address real problems we're making silly pictures, spitting out marketing copy and vaguely improving voice assistants. A ChatGPT-powered search uses ten times the energy of a Google search; generating a single image can use as much energy as charging your phone.

Why aren't we putting generative AI to better use? Here's a theory: perhaps current AI techniques aren't capable of addressing these serious challenges. Rumours abound that the latest AI models hidden away in labs are a huge leap forward, so powerful that the few who have been lucky enough to witness their workings can barely believe it. But not so powerful, it seems, that they can keep energy bills down.

At the same time, those building generative AI have warned that artificial general intelligence and the looming singularity could be existential threats to our well-being. But what these tech bros and CEOs are leaving out is that the energy used in simply trying to build super-smart AI could kill people through the deadly impacts of climate change. (The climate crisis is

already killing people, though we don't have a solid figure: a researcher from Georgetown University estimates about four million lives have been lost to date, while the World Health Organisation estimates that 250,000 will die annually going forward.)

And there's no guarantee that AI will ever deliver on the promises made by the tech industry. This global gamble may never pay off.

Bill Gates is correct that data centres are far from the largest contributor to

climate change. The International Energy Agency says that data centres and data transmission networks each account for 1% to 1.5% of global energy use. Improvements in efficiency have helped hold that in check – but it's now expected to double by 2026.

“There's no guarantee that AI will ever deliver on the promises made by the tech industry. This global gamble may never pay off”

None of this is unexpected. You may recall a scandal in 2020 in which Google demanded one of its own researchers, Timnit Gebru, retract a paper she coauthored: "On the Dangers of Stochastic Parrots: Can Language Models Be Too Big?" The paper lists a few potential pitfalls of the current techniques for building LLMs, none of which will surprise *PC Pro* readers: we increase the size of these models for better accuracy, but that has serious energy, financial and access costs. Perhaps we should design them better rather than bigger?

The paper noted that the huge energy demands of these massive models would inevitably exacerbate the climate crisis, and that the people most likely to be hurt by extreme weather are those who are the least likely to benefit from LLMs.

In the past four years, Google hasn't addressed these problems, at least not publicly. Instead, it – and the rest of the tech industry – has let its previously solid efforts at greening its data centres and choosing renewable energy sources be swept away by generative AI.

Relying on AI to fix the problems caused by AI is wrong-headed. Fix the problems first, and if AI can't do that, perhaps it's time to admit this isn't working as well as we'd hoped.

 work@nicolekobie.com



Time for the broadband chat



Barry Collins is sorry he didn't look out for Colin as much as Colin looked out for him. Email barry@mediabc.co.uk
X @bazzacollins

Find out how much your family is paying for broadband, because it's probably too much

Can you get Baz to have a look at mum's broadband connection? She seems to be paying £70 a month for it." So comes the request from my brother-in-law, who's been going through his mum's finances after the death of my father-in-law.

Seventy quid a month? She can't be. That bog-standard 30Mbps/sec connection that the kids complain about every time we visit? Even BT wouldn't have the brass neck to charge £70 for that. A recent press release from Broadband Deals claims the UK's average monthly broadband package costs £26.90, and their connection is *very* average. There must be some mistake.

It turns out the only mistake was mine, for not checking how much my in-laws were paying for their broadband package years ago. For they were indeed being ripped off by the country's biggest broadband provider – and if BT's lawyers take exception to the use of that phrase, bring it on. I've sent my suit to the dry cleaners, I'll defend that one in court.

"I'm very sorry for your loss," says the chap in BT's bereavement department, when I ring to sort out this mess. I presume he's referring to the death of my father-in-law and not the hundreds of quid they've been overcharged for a run-of-the-mill broadband line, but I can't be sure. His sheepish tone when I explain they're paying £70 a month for a 30Mbps/sec line is telling, however.

Nevertheless, BT is initially reluctant to budge. My father-in-law agreed a contract at that price that doesn't expire until March, the chap explains. We can cancel the contract

now without penalty, as the contract died with him, but if we want to keep the line and crucially the telephone number connected to it, we'll have to keep paying £70 a month.

That telephone number is critical to my mother-in-law. She's just lost her husband, people are calling regularly to check she's okay. And now BT's bereavement department is using it as a bargaining chip to keep overpaying for a broadband line. Even if we immediately sign up with a new provider, there will be a break in service, because this is a contract cancellation, not a straight transfer, and there's no guarantee a new provider will be able to retain the phone number, we're told.

At this point, I rather lose my rag. I'm a technology journalist (yes, I said it, I'm sorry), I write an awful lot about broadband, I know how much a 30Mbps/sec connection should cost, you're ripping off my family, even after a bereavement. It's shameful.

After more than an hour of haggling, I'm about to give the BT chap an anatomical description of where he can shove his contract, when the fella "has an idea". This is against the rules, he tells me, but he's going to chat to his colleagues at EE, the provider BT bought a while ago. We can take out a new, much cheaper deal with EE, with no loss of service, and they'll treat it as a transfer and waive the early termination fees. How generous of them.

I'm reluctant to do it, but it seems the easiest way out. Gail's phone line and broadband connection remain uninterrupted, the bill is cut by more than half, and the disruption is minimal. I take a deep breath and, with Gail's consent, agree. And then the line goes dead.

“Be very un-British and ask friends and family, particularly elderly relatives, how much they're paying for their broadband”

For the next week I spend hours on the phone to BT. More lines are dropped, calls aren't returned, deals that were offered suddenly vanish. At one point they tell me the connection was so expensive because it had a 4G backup provided, even though there's no evidence of that in Gail's home. And what were they doing selling 4G backup to an elderly couple anyway? They could probably get by without *Bargain Hunt* for a day or two.

I finally lose patience and decide to transfer to Zen Internet, even if it means loss of service and the telephone number. But here, too, there's a problem: Gail's exchange is currently over-subscribed. If Zen tries to take the line over from BT, she will go to the back of the queue and almost certainly lose service for an unknown period, even though she's only moving from one Openreach provider to another. No, I don't understand that either. All I know is we're stuck with BT for the foreseeable, albeit – finally – at a reasonable price.

So, the point of this tirade is not just to batter BT, even though it deserves a good hiding. It's to advise you to be very un-British and to ask friends and family, particularly elderly relatives, how much they're paying for their broadband. Because I guarantee that my father-in-law wasn't the only to be talked into taking a vastly overpriced contract because he didn't know better. And, trust me, it's much easier having those conversations when they're alive than when they've gone.

barry@mediabc.co.uk

“Seventy quid a month? That bog-standard 30Mbps/sec connection the kids complain about every time we visit?”

"Ticks all the boxes"



"Fantastic quality"



"Outstanding combination!"



"The best printer"



"A cut above"



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devices that keep people and processes
functioning without fuss.

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Readers' comments

Your views and feedback from email and the web

Just before this magazine went to press, the technology world was upended by the CrowdStrike/Windows outage. As the Readers' comments pages are among the last that are designed, we were able to make late changes and include the star letter that dominates this page. Our thanks to Peter, and to everyone else who wrote in.

Star letter

CrowdStrike lessons to learn



Your PC ran into a problem and needs to restart. We're just collecting some error info, and then we'll restart for you.

20% complete



On the morning of Friday 19 July, I began my usual morning routine of Fruit 'n Fibre, coffee, social media. A Facebook support group for the EMIS software used in general practice already had messages of a problem connecting to the software which, frankly, is not unusual. I scrolled on, confident that it just needed someone to do the necessary reboot.

It soon became clear this wasn't a normal day. I'm a nurse working as an advanced clinical practitioner. As I arrived for duty, it was quickly evident that my practice was affected and we had no idea when it would be resolved. We had no access to patient records and so would need to record consultations by other means until advised otherwise.

To some degree there wasn't a big problem. We could (and did) still see patients, examine, diagnose and advise. But there were problems that I don't think most people would foresee. We couldn't see any medical or medication history. This is not uncommon and is surmountable with good old-fashioned clinical history as you may have experienced in A&E where they don't have your GP records. However, I couldn't access any notes pertinent to the problem at hand or see previous clinicians' input.

Furthermore, patients' understanding of their medical history and medication is often scanty. There's one point that we should take from this issue: please record your medication somewhere such as on your smartphone's Health app, as knowing your medication as "some little white ones" isn't helpful to you or to the clinician treating you.

I couldn't see blood or X-ray results, nor request either. Only by using an old paper

system could I send urine samples to the local laboratory. For onward referrals, I typed letters that could be sent another day but specialist referrals, mainly those on cancer pathways, are done on templates that are processed and sent in a particular way using software to which we had no access.

Then we come to prescribing medication. Normally, the computer will show me current and past medication, blood results and allergies. I am therefore best able to safely prescribe. To anyone who thinks that prescribing medication is just a matter of knowing the right drug for each diagnosis then you have no idea of how many variables are at play, such as how medication interacts and how the patient's age and health need to be considered. We continued to prescribe using the old little green prescription pads, which I hadn't seen in years. In some cases this was indeed fairly simple, but in other cases it was difficult to do safely.

Each patient has been seen and treated to the best of our ability, but now we have a backlog. When the software is back up and running every patient who has been seen will need to have their notes added to the software, the referral letters written and sent and the investigations requested. When is this going to happen? I've already planned to go into work on an annual leave day that I was using for a personal event. I'm sure most clinicians will do extra hours with no expectation of recompense due to the nature of what we do and being dedicated to our patients, but really anyone in any industry working overtime as a result of this should be paid for their hours, right? Can we expect CrowdStrike to compensate every affected business?

As practices we coped. We resorted to old proven methods and of course employed our clinical skill. But what redundancy is there for when this happens? As a technophile I hate to admit it but often "the old ways" of pen and paper do work and shouldn't be wholly abandoned. What if this had been a cyberattack? How can one bug bring down so many systems internationally?

This incident has highlighted the frailty of IT, which in this context of healthcare is an apt simile. **PETER JONES**

CrowdStrike crisis

I get that CrowdStrike should test its releases better. What few people seem to be asking is how companies such as airline services and Sky News, where Windows machines working is mission-critical, managed to update all their machines without doing their own testing first.

How much did this cost in operational and reputational damage? How much would it cost to install the patch on a couple of machines and test it for a couple of hours?

It's as interesting to see the companies that weren't caught out as the ones that were. I work for banks. The ones I've been at always test operating system patches.

It should not be routine to install any external software on business-critical systems. One of the industries affected were the airports. These are charged with preventing people entering the country illegally and they're blindly installing third-party software they haven't checked? **Chris Jack**

Ageing technology

Barry Collins' Viewpoints column (see issue 358, p22) certainly struck a chord with me as I've been having all the same issues for 18 months with elderly parents. Maintaining a reliable, easy-to-use phone

capability has been a real challenge. I've tried all sorts of "accessibility" settings and "apps for the elderly" on a smartphone, but none were that great, and as people's dexterity deteriorates a touchscreen phone becomes unusable. I've looked at the usual Doro options, too, but had to dismiss them as the tracking only works when the SOS button gets pressed.

The sole thing they coped with was a basic phone, largely as this is what they have been used to for 70 years and was hardwired into their memory. I changed them to a "big button" DECT landline phone (still on copper) to use the speed dials only. Even this has proved a challenge, but it's been the most successful.

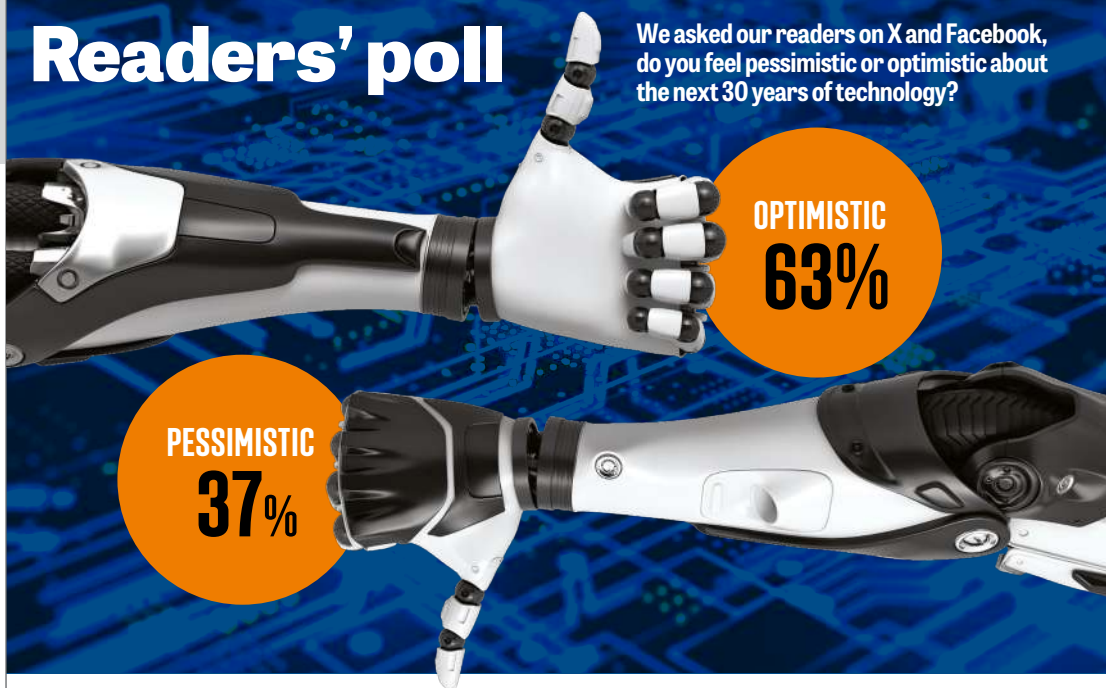


This month's star letter writer wins a Cherry KC 200 MX mechanical keyboard, worth £80, recipient of a five-star review and a PC Pro Recommended award. Email letters@pcpro.co.uk



Readers' poll

We asked our readers on X and Facebook, do you feel pessimistic or optimistic about the next 30 years of technology?



When one of them went into a care home the problem renewed itself as the care home relies on Wi-Fi Calling. To get around this I intend to use an XLink device (myxlink.com), which allows a standard phone to make calls via a mobile. Hence they can use (what they think) is their normal home phone.

Tech is pivotal for helping people maintain their independence, but it has to be super simple to use. I very much like Barry's Alexa idea and will investigate using it too. **Tom Mace**

Loyal reader

Subscriber/reader from issue one here. I'm fascinated by the changes in the magazine. From hardware to software, typefaces to staffer's faces – and then there's the freebies. Here's my free T-shirt, still being worn and much mocked by family. Good quality, though, much like *PC Pro* itself. **Martin Hooper**



Don't get too close

I recently purchased one of the *PC Pro* recommended all-in-one printers, the Canon TS8750. The printing is fine but it's impossible to scan an A4 photo at the claimed supported resolution of 2,400 x 4,800. When I contacted Canon support I was told that such a resolution was only available for scanning small objects like coins or stamps.

Am I being unreasonable in my expectations? Is the same true for other manufacturers? **Ken Rennoldson**

Tim Danton, editor-in-chief, replies: Thanks Ken. Although I couldn't get a definite answer from Canon, it does appear to be industry practice. There is some common sense to this, as such resolutions are massive overkill for A4 prints as their original resolution won't come close to this, but it should certainly be made clearer (by us and the printer companies).



Reasons to be cheerful: one, two but not three, with almost exactly two-thirds of *PC Pro* readers optimistic about the future. Well, kind of. "Optimistic about the tech, but tech is inert, it has no good or bad," wrote Stu Siddons on Facebook. "Pessimistic about how it will be monetised and weaponised. Like how the web is great, but ad-driven profit models have driven the very worst corporate and social behaviours." A thought echoed by Mark Hall, also on Facebook, who was "positive about the tech, not convinced social media is going to survive – which is odd considering where I'm typing this."

We saw the same mixed views on X. "I'm optimistic about the technology (VR, AI, robotics etc) but very pessimistic how they will be used by increasingly-mega corporations," tweeted Ryan Thomas (@RyFish). "I have no faith in OpenAI, Meta, Google or future firms to not make the world a worse place solely because of their hubris/desire for profit."

The aptly named @Lycan_blues had this to say: "Pessimistic because we are already caught up in a cycle of incremental advancement which generates e-waste we do not address, and which AI-driven hardware will increase the waste x10."

But let's leave on a literal up. "The *Star Trek* timeline is currently playing out in real-time," wrote Nick Kitchen (@NukesSix). "Warp Drive in the 2060s followed by first contact with an advanced alien species. Okay, there's a little World War III between then and now but it all works out okay in the end. Beam me up *PC Pro*."

“Pessimistic, looks like heading to a grim Cyberpunk future, with current world politics”

Gareth Bowen

“Cautiously optimistic – but all too easy for things to go ‘SkyNet’...”

@Brownie1871

“Optimistic. We might finally get a next-generation Amiga.”

Steven Croucher

“Optimistic, hopefully disabled equipment powered by tech will become cheaper and make life easier.”

Jamil Khan

Join the debate



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30 GREATEST MOMENTS IN TECHNOLOGY... EVER!

AS PC PRO HITS ITS 30th ANNIVERSARY, WE PICK OUT
THE 30 MOST MOMENTOUS EVENTS FROM 1994 TO 2024 – AND
THROW IN A DIRTY DOZEN OF “FAILS” FOR GOOD MEASURE

CONTRIBUTORS: Stuart Andrews, Barry Collins, Tim Danton, Jon Honeyball,
Nicole Kobie, Dick Pountain, Nik Rawlinson, Davey Winder

They say a week is a long time in politics, but it is as nothing compared to three decades of technology. As we painstakingly compiled this list – whittling it down from a long list of over 150 notable events and product launches – it quickly became clear that *everything* has changed.

When *PC Pro* launched, computers were boring blocks of beige; Apple was more of a laughing stock than an investment stock; and going online involved a stern warning to your family that they couldn't make any calls for the next ten minutes. And phones, believe it or not, were indeed entirely used to make calls.

Now, we appreciate that none of this will be news to you. But what we hope you find as fascinating as we did was to go through the years, enjoying the hits along with the misses. And yes, we're well aware that you probably won't agree with our picks.

Fortunately, one thing hasn't changed: if you disagree with us, just get in touch (although our email address, which used to be writeon@pcpro.co.uk, is now letters@pcpro.co.uk). But most of all, thanks for being along for the ride, whether you joined us for issue 1 or 351. Here's to the next 30 years of great moments!

1994

WORLD'S GREATEST MAGAZINE LAUNCHES

Dennis Publishing launched *PC Pro* in 1994, but we should remember it was built upon *Windows* magazine (itself only two years old at the time). *Windows* mag was the prototype, the beta build. It had a monthly column by me [Jon Honeyball] all about Windows NT, a far-reaching viewpoint at the time. From this, we expanded the idea to Real World Computing columns, populated by friends and colleagues who were subject experts that I knew well from the CIX forums. Soon after, I was given the back page, with the mission to fill the letters page of the next issue with brickbats and the occasional letter of praise.

It has been a fascinating arc of time, from the arrival of mainstream computing with the masses, the rise of the internet, the shift to mobility, and computing ubiquity with always-on and IoT. Today's world is quite different from that of 1994 – who remembers the hell of finding drivers before “plug and play” really arrived? – but the underlying fundamentals of *PC Pro* are the same.

Did we foretell the changes back then? I think we did, and with remarkable prescience, too. We kept our focus on the rise of big computing, in the shape of Microsoft's emerging BackOffice platform, the rise of NT and cross-platform and multi-CPU computing.

It's easy to pat ourselves on the back, having seen off all other worthy competitors like *Personal Computer World*, *PC Magazine* and a raft of others. We have just been doing our best, and taking you along for the journey. Hopefully the road has many more miles ahead of us. JH



1995

MAN BUYS A BOOK

On 3 April 1995, John Wainwright bought a book: the gripping *Fluid Concepts and Creative Analogies: Computer Models of the Fundamental Mechanisms of Thought* by Douglas Hofstadter. A software engineer, Wainwright was friends with Shel Kaphan – Amazon's first employee, aside from the owner of the company – who encouraged him to set up an account. Every river needs a source, and from these humble beginnings Amazon would become the roaring torrent that it is today.

Like all the great American technology startups, Amazon started life in a garage. This one was in the city of Bellevue, near Seattle, and belonged to a guy called Jeff Bezos – who quit his lucrative Wall Street job to found the company in 1994. By 1998 it had made its way to the UK's shores and was selling computer games and CDs, rapidly expanding into all areas of consumer electronics and toys by 2000.

Bezos is now worth a cool \$200 billion, roughly seven billion times the price of Wainwright's first purchase. TD

SONY MAKES GAMING COOL

Sega and Nintendo popularised console gaming in the UK, but it was the launch of Sony's PlayStation in 1995 that changed not just how video games looked and played, but who played them. Launching in between the underpowered Sega Saturn and Nintendo's cartridge-based Nintendo 64, the PlayStation combined advanced 3D graphics with the capacity of CD-ROM to deliver games that were more ambitious, more spectacular and often more adult in their appeal.

Early games such as *Tekken*, *WipEout* and *Resident Evil* went beyond the traditional teenage audience to pull in a new crowd of hip young twentysomethings, making gaming something it had never been before: cool. And as Sony's platform matured, it pushed games in a more cinematic direction, with titles such as *Final Fantasy VII* and *Metal Gear Solid* that stood up as

BELOW The Sony PlayStation made gaming cool





epic blockbusters with engaging stories and Hollywood production values. While PC gaming in the same period was just as revolutionary, the PlayStation helped make console gaming the mass entertainment form it is today. **SA**

WINDOWS GOES BLOCKBUSTER

The hype was palpable. The product launch was huge, with camera crews in Leicester Square in central London interviewing the attendees. It was staged like a Hollywood blockbuster first night, and the crowds filled up the square to gawp. The launch was so successful that an elderly relative bought a copy, despite not having a computer at the time.

And it was a big deal, the arrival of the first 32-bit Windows operating system aimed at the mainstream. NT was working away in the workstation market, but this was modern computing for the common man. It iterated quickly with service packs, and the odd add-on or two, and then Windows 98 became the update. Let's ignore the

somewhat sad Millennium Edition, and remember how the strong NT core was used to transition the Windows 95/98 world onto a single platform.

Back then, the beta testing for 95 was done in a small CompuServe forum, and everyone was there, including the leading lights of the project such as Brad Silverberg, who took a direct and personal interest in how "Chicago" – Windows 95's codename – was progressing. I still have some Chicago beta CD-ROM discs somewhere in my filing system.

Us more extreme power users were motoring ahead with multi-CPU monsters running Windows NT – I will never forget my Asus motherboard with two Pentium Pro CPUs and a ton of RAM. But this capability was to come to the 95 family some years later.

Windows 95 injected a big boost into the PC market, and without doubt pushed personal



ABOVE Garry Kasparov, beaten by Deep Blue in 1997

computing forwards. But I can't let the moment pass without mentioning the utterly cringeworthy onstage dancing of Bill Gates at the American launch (tinyurl.com/36ocringe). **JH**

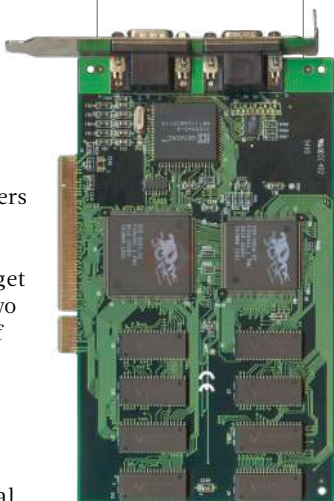
1996

VOODOO BRINGS 3D POWER TO PC

In 1996, PC gaming had a problem. Sure, the PC was the leading platform for cutting-edge 3D games, with showcase titles like *Doom*, *Duke Nukem 3D* and *Strike Commander* that used advanced 3D texturing techniques to create more believable 3D worlds. Yet everything was rendered in software on the CPU, ensuring that only those with the money for Intel's top 486 and Pentium chips saw these games looking good, and even then only at low resolutions.

3dfx, a company founded by ex-Silicon Graphics employees, saw the potential of dedicated 3D hardware, and its initial Voodoo Graphics chip was built specifically to take over the texture-mapping, shading and anti-aliasing workloads that overwhelmed the CPU. Available in reasonably affordable \$350 cards from OEM partners Orchid and Diamond, Voodoo Graphics

BELOW 3dfx's Voodoo Graphics chip brought added realism to PC gaming



brought smooth, high-resolution 3D graphics to PC, along with custom APIs that enabled developers to use the latest 3D features in their own games. In doing so, it created a market for the high-performance graphics processors that would evolve into the powerhouse GPUs of today. **SA**

1997

KASPAROV GETS DEEP BLUE BLUES

It's too simplistic to trace the birth of modern-day AI back to 1997 when an IBM supercomputer beat the dominant world champion – some believe the greatest player ever – over six games of chess. But it certainly told the world that computers could match human intellect in novel areas, with Deep Blue shocking Garry Kasparov (and the world) with a knight sacrifice on move eight of the sixth and decisive game.

Some believe that IBM's victory injected fresh energy into AI, which had stalled after early successes in the 1970s, but we need some perspective here. It took IBM a further 14 years before Watson would famously defeat two all-time champions at the American TV quiz show *Jeopardy!* in February 2011, and the UK's DeepMind – which would go on to create AlphaGo in 2015, having

1994

DECEMBER

Netscape Navigator launches (see p123), leaving Mosaic in its wake

1996

MARCH

Palm Pilot brings computing into the handheld era

1997

DECEMBER

Pision Series 5 adds real keys! The 5mx follows in 1999

1999

JANUARY

First BlackBerry device (the 850) shakes up workers' lives

1999

JUNE

Sony AIBO makes robots cute with one wag of its tail

been bought by Google three years earlier – only came into being in 2010.

Still, I'm willing to concede that Deep Blue's victory was a telling one for AI. And, some would argue, a chilling one for humanity. TD

YAHOO WHO?

Chances are that you remember the truly awful days of searching the early World Wide Web. At first we relied on human-curated portals and web directories – which is what Yahoo started as in 1994 – and many will gratefully remember the appearance of AltaVista as an alternative in the mid-1990s. But even as AltaVista was gaining in popularity, Larry Page and Sergie Brin were working on a research project at Stanford University called "BackRub". The key



idea: to rank pages based on which pages linked to which other pages.

This would develop into the famous PageRank algorithm, with the pair registering Google.com in 1997. And by the end of 1998, with 60 million sites crawled and indexed, it was said to work better than any of its rivals. Including Excite.com, which reportedly turned down the chance to buy Google for less than \$1 million.

That's arguably the worst business decision in the history of the internet, with Alphabet – Google's parent company – now worth \$2,250 billion and Page and Brin sitting atop roughly \$150 billion of shares each. Although notably I discovered that using Copilot, rather than Google. TD

1999

A FAREWELL TO CORDS

Standards are wonderful things – without them, no device would talk

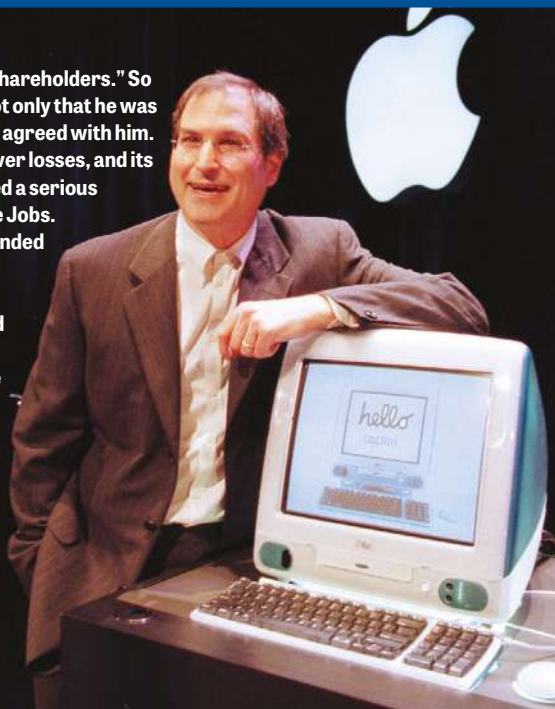
1998

NEW OLD JOB FOR OLD NEW JOBS

"Shut it down and give the money back to the shareholders." So said Michael Dell in 1997. It's hard to believe not only that he was talking about Apple, but that many would have agreed with him. The company had just announced its biggest ever losses, and its hardware, software and sales channels needed a serious shake-up. Who might take on such a job? Steve Jobs.

Jobs had co-founded the firm, resigned, founded NeXT, then come back as an advisor. Within 12 months of his return, he was interim CEO, had ditched 70% of the company's products, ended its agreements with third-party Mac manufacturers, and launched the online Apple Store. Within a year, the company turned a profit of \$300 million.

What looked like a series of gambles followed, each of which paid off: translucent iMacs and iBooks, standardising on USB, building computers without floppy drives. Investors were rapt, and they hoovered up Apple stock. In 2006, it overtook Dell, and Jobs emailed his staff. "Team," he wrote, "it turned out that Michael Dell wasn't perfect at predicting the future." NR



ABOVE Steve Jobs proudly shows off the game-changing fruity iMac

to another. It might be hard from a 2024 perspective to think of the world without wireless communication, but it happened five years after the launch of PC Pro.

The ITU – or International Telecommunications Union to its friends – had a first stab at defining a public Wi-Fi protocol in 1997, called 802.11-1997. 802.11 is the committee name responsible for this area of technical definition, and you can guess the meaning of -1997. However, as standards go, it was much too woolly and never took off.

So the ITU went back to work and defined 802.11b, which came out in 1999. This was the first proper attempt at a Wi-Fi standard both for devices and wireless access points, and it worked well. We might scoff at the low speeds today, but at the time such a connection was revelatory. The first mainstream device to ship with 802.11b was the Apple iBook, and the success of the platform led

to the arrival of the Wi-Fi Alliance, which now owns the trademark for Wi-Fi and manages it.

In the same year of 1999, 802.11a was also launched, offering Wi-Fi in the 5GHz public band. Although this would give higher speed, the increased radio frequency led to lower range, as physics inevitably took its toll.

From these early starts, the standard moved forward to G, N and then AX, with this AX era bringing in the 6GHz range, too. And now we're in the early days of BE, also known as Wi-Fi 7. Let's not forget about the upwards compatibility of the Wi-Fi standard – a BE device should talk happily to an N device, because they negotiate the best that can be done by each end, arriving at a common workable standard.

Also let us not forget that, for many people, "Wi-Fi" is "the internet". Despite this sloppy and imprecise

BELOW Cables away: the first Wi-Fi standard arrived in 1997



2000

MAY

US military unscrambles GPS and revolutionises satnav

2001

NOVEMBER

Apple iPod gives us our entire music library in our pockets

2002

NOVEMBER

Fossil introduces the Wrist PDA to work with Palm Pilots

2002

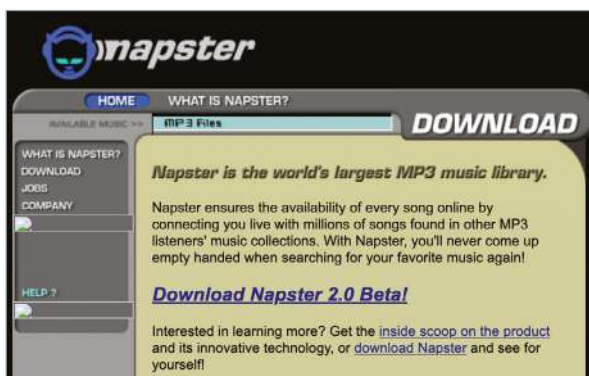
FEBRUARY

Intel debuts Hyper-Threading concept in Xeon server chips

2002

SEPTEMBER

iRobot launches Roomba, the first "affordable robot vacuum cleaner"



definition, Wi-Fi connectivity has become utterly ubiquitous. **JH**

NAPSTER RIPS UP MUSIC INDUSTRY

I started collecting American R&B records in the early 1960s when finding rare 45rpm discs was difficult; many hours were spent rifling through bins in second-hand shops. I stumbled into computers in the early 1980s and onto the internet early too, and began to wonder: where is my worldwide online library of recorded music?

Napster seemed at first like it might be it. Started by Shawn Fanning and Sean Parker, it was a peer-to-peer sharing system that let you access other people's collections of MP3 music (ripped from CDs) and let them access yours. You could even have found my rare copies of Ritchie Barrett's "Some Other Guy" and Billy Boy Arnold's "I Wish You Would".

Problem was, well before broadband this took 15 to 30 minutes to download a single track over a 56Kbits/sec dial-up connection (with fingers crossed it would stay up). Even so, the record companies hated Napster so much they spent millions to drive it into bankruptcy by 2002, even threatening to sue its users too. **DP**

POST OFFICE SCANDAL BEGINS

We didn't appreciate its significance at the time, but in 1999 Fujitsu rolled out a new IT system called Horizon to Post Office branch offices. And unlike every other IT system in history,

ABOVE Napster: scourge of the record industry

apparently this one was perfect, so when postmasters and postmistresses hit problems when balancing their books the cloud of suspicion fell on them rather than buggy code.

Despite two BBC documentaries, a book, *Computer Weekly's* continued investigations, *Private Eye* exposés and an excellent podcast, it took an ITV drama in 2024 to bring this scandal into the public consciousness and in turn put so much pressure on politicians that we got an apology from then Prime Minister Rishi Sunak. But the saga continues. Many victims and their families still await the promised compensation, no-one from the Post Office has yet been prosecuted, and the public inquiry rumbles on. **TD**

2000

PLANES DON'T FALL OUT OF THE SKY

It might seem odd to herald the Millennium Bug as one of tech's greatest moments, but it genuinely was a triumph of international planning and cooperation that the Y2K bug turned out to be a minor nuisance. The bug – created by parsimonious programmers saving precious memory by storing year dates as two rather than four digits – at one time threatened to bring down banking systems, air traffic control and all manner of other critical infrastructure.

As it turned out, billions of pounds' worth of remedial work in the run-up to the year 2000 meant that a Norwegian nursery offering a place



ABOVE A bug that was fixed before it broke everything...

BELOW Not over the Horizon: still fighting for justice 25 years on



to a 105-year-old woman makes the list of worst Millennium Bug consequences on Wikipedia. As Bill Clinton put it, the Y2K bug was "the first challenge of the 21st century successfully met". **BC**

BROADBAND BREAK'S NAN'S ENGAGEMENT

The arrival of broadband in the UK at the turn of the millennium is often remembered for its speed: a jump from the 56Kbits/sec (if you were lucky) dribble of dial-up to 256Kbits/sec or even 512Kbits/sec for the Honeyballs in the house. But the advent of broadband brought two far more significant changes than the bandwidth boost.

It was the first time that data and voice could be split on a single telephone line, meaning nan was no longer frustrated by engaged tones every time she tried to call in the evening. More importantly, you weren't paying by the minute for access, meaning you could relax online without fear of running up a bill that would make Warren Buffett wince. **BC**

2003

APPLE UNWITTINGLY KICK-STARTS THE REPAIR MOVEMENT

Follow the Right to Repair (R2R) movement to its roots and you'll end up in a college room observing Kyle Wiens failing to fix his broken Apple iBook G3. His frustration at being unable to find any repair documentation led to Wiens founding iFixit in 2003, now the planet's premier voice for fixing and repair.

By 2019, the site had over 50,000 guides covering 13,500 devices. Its teardowns exposed poor design choices, hidden screws, glued components, non-replaceable batteries and software locks. As iFixit gained traction, the legal clashes between repair advocates and manufacturers increased, with tech giants finding that Wiens wasn't scared of calling out their anti-repair b*****t.

2003

FEBRUARY

PB iFixit launches, later to become iFixit

2003

MARCH

3G arrives in the UK with the big sell of video calls

2003

JUNE

Second Life goes official and Barry Collins goes undercover

2003

AUGUST

MySpace launches. In 2005, News Corp buys it for \$580m

2004

MARCH

First DARPA Grand Challenge for autonomous vehicles



iFixit became political, highlighting unsustainable anti-repair practices in courts around the world, inspiring other repair specialists to speak with authority about their experiences. Slowly, they disarmed the well-funded lobbyists and lawyers, convincing lawmakers that the reintroduction of repair is vital to combating the global e-waste crisis.

There's an irony that Apple inadvertently began the global R2R movement. It has been forced (along with others) to alter elements of its devices that deliberately hindered repair. As the R2R fight goes on, iFixit continues to lead from the front. **LG**

2005

THE ROOTKIT OF ALL EVIL

One of the big dangers of using pirated software was, and still is, compromising your computer with malware. But what if your genuine audio CD purchase deliberately infected your computer with malware? That's what Mark Russinovich, a security researcher with Winternals at the time and now the Microsoft Azure CTO, told the world on 31 October 2005. He wasn't the first to discover the problem, but Russinovich blew the whistle on Sony after others were given legal advice that any reporting would breach a 1998 US law prohibiting the removal of copyright protection.

The Sony rootkit stealthily installed itself on any Windows PC when the CD was inserted. It had the effect of making the system blind to any files starting with "sys" and was meant to prevent illegal copying of the disc. It also meant that antivirus software couldn't see these files, and hackers soon realised they could rename malware code to start with "sys" and be just as invisible. It's estimated that more than 20 million CDs distributed by Sony BMG contained the rootkit malware, with thousands

FAIL

2004

THE GREAT TIME WASTING BEGINS

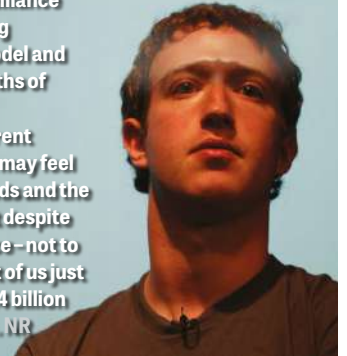
Twenty years ago, Facebook began life as "facemash", a website cobbled together by Mark Zuckerberg and some former friends to let students decide which of their peers was the most physically attractive. By 2006, it had evolved into a social network that opened its virtual doors for everyone to connect - and waste as much time as possible when they should be working.

From such humble beginnings, Facebook has come far: its lack of care around data privacy sparked record fines on both sides of the Atlantic; its surveillance powers and algorithmic content promotion are credited with destroying democracy and sparking the rise of global populism; and its business model and lack of moderation has provoked accusations of contributing to the deaths of bullied children as well as a whole genocide in Myanmar.

With Oculus Rift, Instagram and WhatsApp acquired into the fold, parent company Meta is unquestionably a tech powerhouse. Though Facebook may feel like a has-been compared to TikTok, it paved the way for algorithmic feeds and the ensuing brand, celebrity and influencer invasion of social networks. But despite newer challengers, the constant controversy and the digital surveillance - not to mention the daily posts by your conspiracy-theorist weird cousin - most of us just can't log off: three billion people use Facebook at least monthly. Given 5.4 billion people have internet access globally, that's remarkable - and terrifying. **NR**

2004

facebook.



of government and military networks among the infected systems.

It proved a good lesson in how not to handle digital rights management or how to respond when caught out. Sony BMG's president at the time, Thomas Hesse, said "most people, I think, don't even know what a rootkit is, so why should they care about it?" **DW**

BELOW Zune: the iPod killer that failed to land a punch



FAIL

2006

MICROSOFT ZUNE

Sometimes history can be cruel. Zune is known as a singular thing, although it went through three generations, from 2006 through to 2011. Microsoft tried quite hard here, developing the first model in conjunction with Toshiba, and the second and third with Flextronics.

The target was obviously the immensely successful iPod

range from Apple. It wasn't just hardware; there was a software service called

Zune Plus and a Marketplace for music, TV and movies. And let's not forget the streaming services for the Xbox 360, and software for Windows PCs, and sync capabilities with Windows Phone.

The first unit came with hard disks from 30GB to 120GB, with some flash models too. But it never made the breakthrough, lagging behind not only Apple but other vendors too. It really was a case of too little, too late.

One historical amusement: the original Zune 30 models stopped working on 31 December 2008, because they couldn't handle the leap year properly. The solution? It fixed itself just fine 24 hours later. And did I mention that the case was brown? **JH**

DEVELOPERS, DEVELOPERS, DEVELOPERS...

There comes a time, approximately 90 minutes into an Apple WWDC keynote that has higher production values than *The Matrix*, that a small part of you yearns for the day a sweat-drenched, middle-aged man started bouncing around a stage like a demented labrador, yelling "developers, developers, developers".

2005

MAY

IBM sells PC division to Lenovo

2005

JUNE

Apple parts ways with Motorola to partner with Intel

2005

DECEMBER

Xbox 360 lands, a major landmark for online gaming

2006

JANUARY

Intel Core processors launch, marking new era of CPUs

2006

JULY

AMD buys ATI for a cool \$5.4 billion



That day was in 2006, at a Windows 2000 developer conference, and it was just one of Steve Ballmer's appearances as the world's best-paid cheerleader.

Seriously, though, it was hard not to be impressed by his overspilling enthusiasm for Microsoft and its staff, and though his record as CEO was patchy, his love for the company was infectious. Sometimes, almost literally. **BC**

SOFTWARE GETS SASSY

It's not that cloud computing was a new concept in 2006, the year Amazon Web Services (AWS) and AWS Elastic Compute Cloud (EC2) arguably took it mainstream. Indeed, AWS was itself born out of the need for Amazon to flexibly meet the demands of its users and its infrastructure, and that idea can be traced back all the way to the 1960s and time-sharing compute resources if you squint.

But every breakthrough technology has an inflexion point, and from this point on we saw an increasing interest – from IT professionals and end users – to shift services from local resources to those on the internet. The downside is that we're all now hooked on monthly subscription fees for software we used to own outright. No wonder Amazon's logo is a smile. **TD**

SERVING DOCS

Google Docs serves as an excellent reminder that we shouldn't judge a product by its first iteration, especially if it's backed by a behemoth such as Google. Docs started as a Writely, an online word processor developed by Upstartle. I remember the first version of Docs as being both



basic and flaky, certainly no true rival to the feature-packed Word.

But over time I've come to use Docs as my main word processor, in part due to that very simplicity – and its shareability, a feature added after Google's acquisition of DocVerse in 2010. Meanwhile, Google has continued its habit of buying software developers with great ideas and integrating them into its suite, with Spreadsheets based on XL2Web (another 2006 buy) and Quickoffice (2012) expanding the offering to mobile definitions.

2012 was also the year Google launched Drive, marking a remarkably quick rise from PhD project in 1996 to true Microsoft rival in the space of 16 years. **TD**

2008

FASTER WAYS TO LOSE ALL YOUR CASH

If you or someone close to you has been conned into giving bank details to a scammer then that cash could be among the £450 million lost to



ABOVE The Faster Payments System helped facilitate the cybercrimewave

Authorised Push Payment (APP) fraud in 2023. The tool that drives APP crime is a legitimate financial mechanism launched in 2008 called the Faster Payments System (FPS). It allows near-instant money transfers for UK bank accounts and was responsible for 98% of APP scam payments in 2023. If you're looking for a technical fail, then FPS is it.

FPS was designed with major flaws. Its real-time nature means that transactions can't be cancelled once they've been sent. FPS is also an irrevocable system, where neither mis-directed fraudulent transactions nor mis-keyed legitimate payments can be retrieved.

It took 12 years and a legal "super-complaint" from *Which?* for the financial industry to introduce

Confirmation of Payee, a basic safeguard so payers can verify account names before transferring money. This was followed by the Contingent Reimbursement Model (CRM), a voluntary code where signatory banks commit to reimbursing fraud victims.

The security holes in FPS enable billions to be siphoned from UK bank accounts, while CRM raises loan ➔

2007

THE NOKIA E62 IS BESTED

There's a curious moment just before Steve Jobs unveils the iPhone, in which he shows a graph showing which leading "smartphones" the iPhone is about to best: the Moto Q, the Palm Treo and the Nokia E62.

You're probably struggling to remember any of them, but you'll likely never forget the iPhone, the device that set the template we're still using today.

That launch video is a reminder of things we now take for granted: a finger swipe up a list of music albums gets a round of applause, as does a map showing the local branches of Starbucks, and rotating the phone to landscape to view photos. The original iPhone had its flaws: no 3G, no App Store. But it's hard to argue with Jobs' assertion that it "changed everything". **BC**



2007

JULY

First PC Pro podcast... and it's pretty awful

2007

NOVEMBER

Amazon Kindle sends shivers down the spine of publishers

2008

FEBRUARY

First Tesla Roadster delivered to... Elon Musk

2008

MAY

Asus launches the Eee PC and the world falls in love with netbooks

2008

JUNE

Apple releases the iPhone 3G, and with it the App Store



and mortgage prices as banks recoup fraud costs. The harsh reality is that consumers continue to bear the financial burden of the FPS fail. **LG**

MAN PULLS LAPTOP OUT OF ENVELOPE

PC Pro has been written, designed and edited in the distributed workplace known as people's homes for a decade now, so we're not entirely sure if internal mail envelopes are even a thing any more in offices. But when Steve Jobs pulled the MacBook Air out of such an envelope in 2008, the gasps from the audience were telling.

This was a laptop that was thinner than anything we'd ever seen before, and by some margin. At its thickest point, it was thinner than the nearest rival's thin end of the wedge. As with the iPhone, its impact on the rest of the industry was dramatic. Soon we had Ultrabooks and all manner of Windows copycats, but even 16 years on, it's still the ultraportable laptop that the rest of the industry is trying to match. **BC**

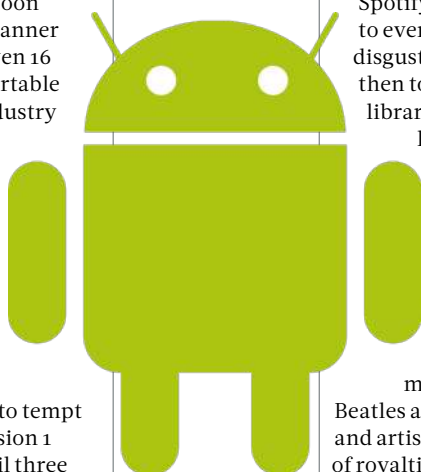
GOOGLE MAKES ITS BEST EVER BUY

It's often misstated that Google developed Android itself. In fact, it bought the operating system from Andy Rubin's company in 2005, after Rubin had failed to tempt both Samsung and HTC. Version 1 wasn't actually released until three

ABOVE Air born: Steve Jobs shows off the thinnest laptop ever seen

RIGHT Spotify: great for music fans, not so great for musicians

BELOW Android: from nowhere fast



years later, but it didn't take long to make up the lost ground on iOS. It went from a 2.8% market share in mid-2009 (according to Canalys), to more than half of smartphone sales by the end of 2011 (according to Gartner).

Android's not just a smartphone OS, of course. It now powers an extraordinary range of devices, from games consoles and routers, to smart signage and electronic bikes. Yes, Google bought extremely well. **BC**

SPOTIFY REDEFINES MUSIC

Lunching outdoors in Italy back in 2009, an argument started over some lyric in a song by Billie Holiday. I hauled out my Sony VAIO laptop, played the track on Spotify and settled the argument to everyone's astonishment and disgust. Spotify seemed back then to be that worldwide online library of recorded music I'd been looking for since Napster folded: fast search, high-enough audio quality streaming, and all the music content I was interested in. Certainly it lacked much major pop music back then – the trauma of Napster kept major acts such as Dylan, the Beatles and the Stones off it for years, and artists have griped about the size of royalties for ever. But for classical,

jazz and other non-chart music it's always been excellent.

Over those years, major record companies have overcome their resistance, and Spotify streams are now a major means of distributing current popular music. It now has over 600 million users, almost half of them paying, and holds 100+ million tunes and 350 million audio books. And it's even had a cultural impact: I recently attended a workshop at the LSE where a group of social scientists discussed Spotify playlists as major sources of cultural identity. Although I was the oldest person present by around 50 years. **DP**

2009

FIRST CRYPTOBRO IS BORN

We'll let you into a little secret: all the powerful desktops sent into the *PC Pro* Labs didn't just sit idle after testing. A couple of the more forward-thinking writers used to deploy them for Bitcoin mining until they were collected. We don't know what became of those writers, we haven't heard from them for a while...

Sometimes we wish we'd never heard of Bitcoin either, but there's no denying the cryptocurrency has had a considerable impact on financial markets, the tech sector (by way of the blockchain) and law and order. We still don't really know who deserves the credit for this invention, although a court ruled this year that it's not Craig Wright. The hunt for the world's first cryptobro goes on. **BC**



2010

SIRI MAKES HER DEBUT

Three years before the much-loved film *Her* hit the theatres, Apple made its first foray into personal assistants with Siri. She first appeared as an app in February 2010, the creation of Norwegian startup Siri Inc, and within two months Apple had fallen for her so badly that it spent \$200

2008

OCTOBER

A gentleman called Satoshi Nakamoto proposes Bitcoin

2008

NOVEMBER

Intel releases its first ever Core i7 desktop processors

2009

MAY

A curious, blocky game called Minecraft launches

2009

JULY

Google releases Gmail and says it's working on ChromeOS

2010

JANUARY

Apple announces iPad based on its own A4 processor



million to keep Siri exclusively on iOS (the initial plan was to roll out the app to BlackBerry and Android phones, too).

Ever since 2011, with the introduction of the iPhone 4s (which now looks tiny with its 3.5in display), Siri has been baked into iOS – and recently Apple has promised it will be enhanced with Apple Intelligence to bring Siri even closer to Samantha, the operating system so memorably voiced by Scarlett Johansson. **TD**

WINDOWS PHONE FAIL

If anything summed up Microsoft's inability to have a clear strategy, it was Windows Phone. Originally launched in 2010 based on Windows Phone 7, the later Phone 8 of 2012 replaced the Windows CE kernel with a Windows NT-derived platform. However, the two versions were incompatible, although previous apps would work. Windows 10 Mobile came along in 2015.

Nokia was one of the major platform providers, replacing its Symbian OS for this new generation of Windows phone. In 2013, Microsoft took the next step and bought Nokia's phone division outright. However, it didn't work out and Microsoft stopped



ABOVE Windows Phone: some interesting ideas bathed in confusion

development in 2017, conceding that the iPhone and the Android platform had pushed it to the sidelines.

Windows Phone, in its various guises, had a lot of interesting ideas, especially around the tiled front end. Some maintain that no platform has since matched it for its information rich and easy to use interface. But you can't push a confusing platform to either customers and developers, and the resultant train crash was almost inevitable. **JH**

2012

A NEW FLAVOUR OF PI

The Raspberry Pi is the world's best-selling computer, with its current 60 million (or so) easily doubling the sales of the Commodore 64. Not bad for a credit-card-sized device produced at low cost in Pencoed, Wales. Spiritual successor to the BBC Micro, the first Raspberry Pi was built for schools by a team at the University of Cambridge, who spotted a skills gap in students applying to study computer science. The boards proved sufficiently flexible and – crucially – cheap enough to quickly outgrow that market and, five major



ABOVE Raspberry ripple: the Pi has been a phenomenal UK success story

releases later, they're a go-to platform for hobbyist makers worldwide.

Since then, they've spawned a healthy and growing ecosystem of compatible operating systems and peripherals, running the gamut from cameras to touchscreen displays. This is no doubt helped by the consistent use of easy-to-access GPIO (General-Purpose Input/Output) pins alongside standard ports such as USB and HDMI.

The company has invested in its own IP over recent years, developing its first in-house microcontroller chip for the 2021 launch of Raspberry Pi Pico and, two years later, unveiling Raspberry Pi 5 with a home-grown I/O controller. It floated on the London Stock Exchange in 2024, and, at the time of writing, its market cap stands at £733 million. That's roughly 26.5 million times the price of the first board – the Raspberry Pi 1B – which kicked it all off in February 2012. **NR**

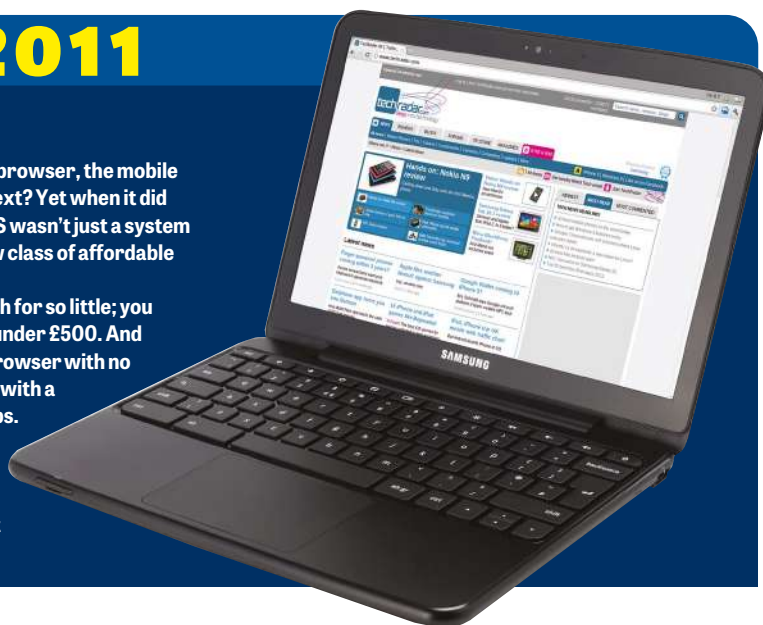
2011

GOOGLE BRINGS A LAPTOP TO SCHOOL

By 2010, Google had already expanded from the search engine to the browser, the mobile OS and the cloud-based office app – surely the desktop OS would be next? Yet when it did arrive, Google's move wasn't quite what anyone expected. ChromeOS wasn't just a system you could install on existing laptops, but the software powering a new class of affordable laptops, focused squarely on the education market.

The first Chromebooks were enticing because they offered so much for so little; you could pick up a thin-and-light laptop with an 11 to 14in screen for well under £500. And while the software was a tough sell to start with – literally a Chrome browser with no support for offline apps – it steadily matured into a fully functional OS with a familiar desktop interface and the ability to run Android and Linux apps.

Even the schools angle paid off, making Chromebooks a familiar sight in classrooms around the world and getting students used to cloud computing. Google went on to redefine the Chromebook through its Pixel, Pixelbook and Chromebook Plus initiatives, but that first run of Chromebooks was quietly revolutionary. **SA**



2010

MAY

Laszlo Hanyecz buys two pizzas for 10,000 bitcoins

2011

FEBRUARY

IBM Watson makes history by winning TV show Jeopardy!

2011

JUNE

Office 365 released; Adobe Creative Cloud follows in October

2011

JUNE

First Google Chromebooks go on sale

2013

JUNE

Edward Snowden leaks classified NSA information



ABOVE Was Tim the only Surface RT user?

RT FAILS TO SURFACE

Okay, hands up: I bought a Surface RT. And yes, I know that Windows RT basically failed, and that ever since listeners on the *PCPro* podcast like to remind me of this. But you know what: the Surface RT was a genuinely nice tablet, and unlike trying to force those tiles onto every Windows 8 computer (I won't defend that Microsoft decision!) they made a lot of sense on a touchscreen device.

Sadly, one device does not make an ecosystem. And without an ecosystem of other tablets, with sales figures into the tens of millions, there's no good reason for Adobe or even Facebook to create an app for the device. Though my tablet continued to give great service for years, Windows RT's allure quickly faded, and I remain to this day the only person I know who ever bought one. **TD**

2014



HELLO, HELLO, ECHO, ECHO

How many Echos do you own? If you're anything at all like us, the answer is edging close to double figures if it's not there already. The fun all started in November 2014 with the limited US release of Amazon's first smart speaker, but this was an early tease: international models followed in mid-2015,



2013

WHAT A GOOGLE GLASS**LE

I'll never forget the few times I wore the Google Glass out on the street. The looks people gave me, a low-rent wannabe cyborg, as I walked around London muttering commands and gazing into the mid-distance, trying to read the faint, blocky text on the tiny LED display.

There were some strengths. Ignoring the privacy issues of a built-in camera, it was a great way to create a virtual tour of my sister's new house. I even gave the *Zombies, Run!* game a good test, giving me a welcome break from my normal running routines.

But let's face it, there's a reason people were called Glass**les when they wore them, and while we've seen some clever (and more discreet) smart glasses for consumers in the past year, Google Glass-style mixed reality headsets have only proved popular in industrial environments where the reward of having a video overlay matches the social pain of wearing the glasses – and their rubbish battery life. **TD**

and before long we were submerged in Echo Dots, Shows and Spots. Barry Collins even fitted a Dot into his car.

As always with Amazon, the range has not been without controversy. Amazon had to pay \$25 million to the Federal Trade Commission for illegally keeping children's voice and location data, and with the microphones always on by default there are obvious security concerns. But overall, Echo has been a triumph for Amazon, far more so than the Apple and Google alternatives. **TD**

LISTENERS SAY NO BONO

"Are we ready to be swept off our feet?" asks one of the lyrics on the U2 song, "Every Breaking Wave". Well, the answer was emphatically "no" when Apple bundled the song's album into every Apple user's music collection, whether they asked for it or not.

Truth be told, *Songs of Innocence* isn't one of U2's better albums. Still, Apple failed to anticipate quite how vociferously many customers would object to having it pollute their iTunes collection. The company was forced to



ABOVE Oi, U2 – get out of my iTunes library!

hastily add a page to its website, providing instructions on how to remove the album.

"I take full responsibility," Bono later wrote in his memoir. "I'd thought if we could just put our music within reach of people, they might choose to reach out toward it. Not quite." A rare piece of Bono understatement there. **BC**

2015

WINDOWS 10: PARADISE LOST

Windows 10 was a revelation. When it launched, I compared it to Elvis Presley during his '68 comeback special. It was a lithe, hip-thrusting, audience-swooning reminder that Windows could still rock.

The development team admitted to the mistakes of Windows 8 and made a seismic offering to millions of users. The path to Windows 10 would be free, the rationale being that Microsoft could improve the customer experience by supporting a single OS. They worked the 10 Insiders hard, but they listened and reacted with duplex transparency and passion. Together, thousands of us slapped 10 into a decent launch product. ➔

LEFT Listening in: Amazon's Echo devices were a hit

2014

FEBRUARY

Satya Nadella steps into Steve Ballmer's large shoes

2015

APRIL

WikiLeaks publishes hacked Sony emails and documents

2015

APRIL

Apple Watch goes on sale after being teased in 2014

2015

DECEMBER

OpenAI non-profit starts work, with Musk a co-founder

2016

MARCH

AlphaGo defeats world champ Lee Sedol; 200m people watch



When it launched, technical miracles happened around the world. We should all remember that Microsoft threw out an upgrade engine that didn't destroy most of the machines that shut down on one OS and awoke on another. There were problems, but the success rate was phenomenal.

Like Elvis, 10's performances at the end of its career lacked the nimbleness of youth. SSDs were the bejewelled jumpsuits masking the sweating and gasping OS that struggled through each performance.

Despite this, Windows 10 retains a phenomenally loyal user base and, for a time, Microsoft succeeded in its plan to unite the Windows users onto one platform. **LG**

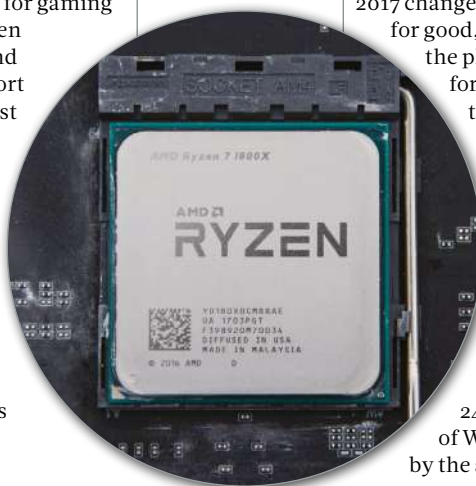
2017

TEAM RED GIVES INTEL THE BLUES

AMD's Ryzen has earned its place in this list. It turned AMD from the "cheap and cheerful" CPU option into a genuine Intel rival and frequent market leader in the sector.

Zen's magic flowed from the firm foundation of the AM4 socket, which AMD developed in 2016 for its Excavator architecture and maintained over the first four generations of Zen. Buyers adored the CPU upgrade path without requiring new motherboards for each new generation. At the time, Intel was offering an incompatible mess.

Ryzen CPUs offered higher core and thread counts at competitive prices, making them ideal for gaming and content creation. Ryzen introduced PCI-E Gen 4 and native USB 3.1 Gen 2 support before Intel and could boast attractive features such as Precision Boost for overclocking support and higher default memory speeds out of the box. Ryzen APUs with Radeon Vega graphics delivered fabulous performance for entry-level gaming – perfect for budget builders who couldn't afford a dedicated graphics card.



RIGHT The worm that turned: WannaCry hit the NHS badly in 2017

BELOW Core blimey: Ryzen chips reinvigorated AMD

Behind Ryzen's success was Dr Lisa Sui, who became CEO of AMD in 2014. Her skill and determination steamrolled Ryzen into the market, squashing years of Intel's dominance. In my mind, it's one of the most important technological achievements of the past decade. **LG**

IT MADE US WANNACRY

The events of Friday 12 May 2017 changed cybersecurity for good, in both senses of the phrase. You'd be forgiven for thinking that at the time, though, as the WannaCry ransomware worm ripped through the NHS, racking up £92 million in recovery costs for 80 hospital trusts and 595 GP practices. Impacting at least 300,000 computers across 150 countries, the first 200,000 in less than 24 hours, the rapid spread of WannaCry was only halted by the actions of a lone hacker,



Marcus Hutchins, who found a "kill switch" URL in the exploit code with an unregistered domain. WannaCry would only encrypt files if no connection to that URL could be made, and by Hutchins registering the domain, WannaCry killed itself.

WannaCry was a worm that exploited an already fixed vulnerability in Microsoft's Windows Server Message Block (SMB) protocol implementation. Some two months after the fix, enough servers had yet to patch to enable the ransomware code to spread like wildfire. WannaCry was also big news as it emerged it used an exploit developed by the US National

2016

PALMER LUCKEY RESURRECTS VR

After multiple disasters, the whole concept of VR looked moribund when, in 2011, the 18-year-old Palmer Luckey built his own PC VR headset in his dad's garage from off-the-shelf parts. Within months, Luckey had dropped out of college and started Oculus VR, announcing the world's first mass-produced VR headset, Oculus Rift. The early Rift DK1 development kit was championed by iD Software's tech guru, John Carmack, who helped port the *Doom 3 BFG* edition to the headset. By 2013 the DK1 was available for developers and enthusiasts to buy. Three years and two updates later, the Oculus Rift CV1 had its first consumer release, with dual displays each with a 1,080 x 1,200 resolution, custom lenses, 360° positional tracking and integrated audio. PC gamers could enjoy the likes of *Alien: Isolation*, *Elite: Dangerous* and *Dirt Rally* in VR for the first time. What's more, the Rift inspired a new wave of professional simulation and visualisation applications, covering everything from troop training to architecture, education and product design.

Who knows if VR will ever become truly mainstream, but without Luckey's work you wouldn't have the Apple Vision or the Rift's descendent, the Meta Quest 3. **SA**



FAIL

2016

MARCH

Microsoft Tay lands and is soon swearing like a trooper

2016

MARCH

Microsoft enters the mixed reality world with HoloLens

2016

JULY

Pokémon Go phenomenon takes over the world

2016

DECEMBER

Apple AirPods appear, and now they're everywhere

2017

NOVEMBER

All Twitter users could use 280 characters rather than 140

Security Agency (NSA). The exploit was stolen by the Shadow Brokers hacking group and eventually found its way into the hands of the North Korea-affiliated Lazarus Group.

The good news is that it woke organisations up to the need to improve patch management, attack surface auditing and incident response planning. The bad news is that it woke cybercriminals up to the scale of profitability that better-coded ransomware could attain. **DW**

2020

ZOOM HAS A COVID MOMENT

Before Covid-19 locked us down in our homes, who had even heard of Zoom? Flawed and out of date though it was, Skype remained the byword for videoconferencing software, despite the rise of Google Meet, Microsoft Teams, Cisco WebEx and the rest.

Then the pandemic hit, and suddenly Zoom was the infrastructure for work and play. It became a digital meeting room, sure, but also a post-work bar, a yoga studio, a concert hall, a classroom and where we saw our family. People held funerals over Zoom, a sad necessity of such terrible times.

Each day in April 2020, Zoom meetings topped 300 million

participants, 30 times more than the previous quarter. Why did we choose Zoom? It's difficult to know for sure, but keeping short calls free and allowing up to 100 attendees surely helped, plus it was easy: you could send a link to a non-tech savvy person and all they had to do was click it to chat.

The post-pandemic shift to hybrid and home working should have seen a continuation of the boom times for Zoom, but the company has had to cut costs with layoffs amid slowing revenue growth. Now, Zoom is trying to expand beyond video calls into a full suite of AI-powered collaboration tools. Whether or not that works in the long run, Zoom ended Skype's long reign as the proprietary eponym of choice for videoconferencing. We no longer Skype, we Zoom. **NK**

2021

THE METAVERSE

It's not as if Mark Zuckerberg was the first person to back the idea of the metaverse – *Second Life* gave it a spectacular go in the early 2000s, Neal Stephenson coined the term in his 1992 novel *Show Crash*, but Zuckerberg was the first person to try to shape his company around it. And then, slowly, back away. Turns out people quite like the real world.



ABOVE Meta guru: Zuckerberg's vision is yet to pass

Where did it all go wrong for Mark Zuckerberg and Meta? For the man who once said, "metaverse isn't a thing a company builds... it's the next chapter of the internet overall"? Some would point to the lack of legs in avatars. Some would point out that just because we can live in virtual worlds doesn't mean we want to. But mostly, just take a look at the VR and AR headsets currently on sale and realise how very far away we are from a seamless "metaverse" experience.

But who knows: maybe in 2054's follow-up feature, 60 greatest moments in technology, the metaverse will have moved from fail to hit. **TD**

LEFT Zoom helped us all through the pandemic



2022

WRITERS TAKE THE REST OF THEIR LIVES OFF

The only reason you can tell this entire feature was written by over-worked bags of atoms instead of ChatGPT is that AI lacks the imagination to insult us in that fashion. However, given the rate of progress with ChatGPT and its ilk over the past couple of years, drumming up ➡

2017

DECEMBER

TikTok starts its invasion of the West with lip-syncing tech

2018

MAY

GDPR comes into force – are you happy with these cookies?

2018

OCTOBER

Google makes foray into large language models with BERT

2019

FEBRUARY

OpenAI launches GPT-2... and nobody notices

2020

MAY

OpenAI launches GPT-3... and still nobody notices

2025

WHAT'S THAT HUGE PILE OF E-WASTE, SATYA?

Why did Microsoft launch Windows 11? Think of a single 11-only feature which has changed your life. Even 11-only perks such as DirectStorage and Android integration were leached into 10. Why? Because 11's market share is around half that of its predecessor.

Microsoft culled the free upgrade (critical to Windows 10's adoption) by erecting restrictive hardware barriers and, while it may protest the technical argument, it's been a disaster for uptake numbers and will be calamitous for the environment.

Current estimates suggest that around 250 million machines aren't compatible, causing working hardware to be added to e-waste mountains around the world. Microsoft is on the verge of committing ecological vandalism on a global scale, and I'll be fascinated to see the justification in its 2026 ESG.

Will this set a precedent? Will Microsoft pull the same stunt with Windows 12 by outlawing non-NPU devices? Other tech firms are addressing sustainability and circularity, but Microsoft feigns deafness. If you work for Microsoft PR, then take a sickie on 14 October 2025 (the day Windows 10 support ends) because, unless Satya lifts some barriers, it's going to be an awful day in the office. LG

FAIL



colourful insults might be all we're good for before long.

Critics smugly claiming that AI is little more than an over-promoted autocorrect don't know what they're talking about. This is transformative technology, and we're not even close to understanding how much it's going to tear up human jobs, the creative industries and what's left of trust in the legitimacy of internet content. We don't understand it because even Sam Altman, the controversial figurehead for OpenAI, admits that even he doesn't know what the next version of ChatGPT will be capable of. It's terrifying, but I can't wait to see what comes next. BC

SPACE KAREN'S ANTI-SOCIAL BEHAVIOUR

It's easy to forget that Elon Musk didn't actually want to buy Twitter; he had to be sued into completing the purchase. Many will wish he'd won that case. An influx of porn bots, the



FAIL

ABOVE X-rated:
Musk has made a pig's ear of Twitter

RIGHT Copilot+ PCs could be the next big thing

readmittance of banned hate-speech spreaders, a fatwa on third-party clients, patchy performance, the handing of "verified" accounts to those shallow enough to pay for them, the mass firing of the people responsible for the network's safety, the outright refusal to be held accountable by the press or, well, anyone. The only small consolation is that Musk's vanity project appears to have cost him a serious chunk of his personal fortune. But let's face it, he's not about to start shopping down at Lidl any time soon. BC

Arm-based chips are not only a match for x86 chips but in many ways superior – not least their AI abilities.

Questions remain. Will local AI be embraced by software developers to such a degree that consumers and businesses start demanding Copilot+ PCs by name? Can Copilot+ PCs drop sufficiently in price? (I think they need to be £600 or less.) Will Microsoft keep on backing it or slowly edge away, as we've seen it do before? Answers on a postcard in five years, please, assuming those still exist. TD ●

2024

COPILOT+ PCs

The jury is still out on Copilot+ PCs, but I'm going to nail my colours to the mast and say they'll come to dominate the PC landscape for the rest of this decade. If nothing else, they mark the first time that



2020

NOVEMBER

Apple rewrites the CPU rules with the M1 launch

2021

JANUARY

OpenAI launches DALL-E, a harbinger of what's to come

2022

APRIL

Midjourney starts its flurry of staggering releases

2023

JUNE

Apple Vision Pro goes on sale in the USA to mixed reviews

2023

OCTOBER

Online Safety Bill finally passes



THE 26-YEAR EVOLUTION OF CYBERPOWERPC



Since its foundation in the 1990s, CyberPowerPC has never stopped innovating

CyberPowerPC has been a pioneer in the gaming industry since its inception in 1998. That's when the company was founded, in the heart of California's tech hub, and a decade later it landed in Britain.

"The inception of discrete GPUs from Nvidia back in 1999 changed the PC industry forever – for the gaming industry, for consumers, for manufacturers and for developers alike" said Steve Mason, CyberPowerPC UK's general manager. "It's changed how PCs were built, how components were designed, how games have been designed, all basically becoming more and more powerful over the years."

Taking full advantage, CyberPowerPC UK quickly gained a reputation for delivering high-performance, customisable gaming PCs tailored to the needs of gamers of all levels.

Over the years, that reputation has only been enhanced. CyberPowerPC UK is determined to push the boundaries of technology to provide cutting-edge solutions for both gaming enthusiasts and professional environments. "We're continuously working to get

the best of PC tech to our customers through our long-term relationships with vendors such as Intel, Nvidia and AMD," said Steve, adding that price is all-important, too.

With a commitment to innovation and customer satisfaction, CyberPowerPC has become a trusted name in the world of custom-built PCs – and particularly so for CyberPowerPC UK in this country.

That's reflected not just in the ever-increasing number of awards CyberPowerPC UK has won, but in its high rating on independent sites such as Trustpilot and Google. "Customer experience is everything to us," said Steve. "We've got to where we are through our hard work in making sure we are doing everything we can to improve our customer journey pre-, during and post-purchase."

With a new headquarters – needed due to its growth over the past few years – Steve says CyberPowerPC UK is well set for the future. "We're continuing to grow our business portfolio, while the quality of our gaming PCs is reflected in the amazing awards we've won in magazines like *PC Pro*!" ●



6 NOTABLE LANDMARKS FOR CYBERPOWERPC

1998

Foundation of CyberPowerPC in the USA, perfectly timed with Nvidia's rise

2008

CyberPowerPC UK brings unique gaming designs to Britain

2010

First business PCs on sale in the UK – and it's been growing ever since

2019

First PC review in *PC Pro* – and it went straight onto the A List

2020

Commitment to creative PCs shown by attendance at The Photography Show

2023

CyberPowerPC's Gaming Bus tours the UK at events!

30 REASONS TO LOVE GEEKOM GREEN MINI PCs

Find out more about the leading brand in the mini PC industry – GEEKOM



1-4 GEEKOM mini PCs occupy a tiny fraction of the volume of traditional desktop PCs.

That means fewer materials are used in the manufacturing process **1**, less energy is required during manufacture **2**, its transportation carbon footprint is much lower than a typical computer **3**, as is each PC's carbon footprint as a whole **4**.

5 Buy a GEEKOM mini PC and get the same performance as a traditional computer, but smaller and greener.

6-8 By using advanced CPUs and efficient cooling, users can run demanding software while using little energy **6**. Plus, GEEKOM's extensive range of models caters to various needs and budgets, reducing the need for multiple devices **7**. Buying such fast devices today means that they will last for years into the future too **8**.

9 Each GEEKOM mini PC undergoes rigorous tests – including high temperature, noise and drop tests – before release, with an average lifespan twice that of industry peers.

10 As AI's environmental burden increases, switch to a local NPU. GEEKOM already sells the A7 with Ryzen AI built in, and will shortly introduce a new product that includes Intel's Core Ultra 9 chip with its own NPU.

11-12 Unlike most laptops, it's easy to replace and repair components inside a GEEKOM mini PC – from the RAM to the SSD to the wireless chip **11**. Plus, there's a lively forum packed with advice **12** on how to get more from your system.

13 GEEKOM uses high-quality, recyclable materials in its products, minimising waste and maximising sustainability.

14 It isn't just about the hardware: GEEKOM also offers excellent support to all customers.

15 Many people use old, energy-guzzling boxes to store and stream media (and indeed live broadcasts). With advanced Wi-Fi built in, the latest GEEKOM mini PCs do it all for you.

16 With an integrated LAN port, it's easy to remotely wake systems when you need them rather than keep them running 24/7.

17 GEEKOM has an R&D team of over 200 people, leading industry trends for both performance and sustainability.

18 It was the first mini PC brand to offer a three-year warranty, something GEEKOM could only do due to the reliability of its products.

19 GEEKOM is committed to using recycled packaging and post-consumer recycled plastic wherever it can.

20 As we move to more flexible workspaces, mini PCs make the most of available space. Perfect if you need to switch to a smaller main office, for example.

21-22 GEEKOM mini PCs are the ideal choice for hotdesking as they can be remotely managed and fitted to the back of monitors **21**. Plus, if you have a meeting room with a big TV, they're a superb choice for running meeting room software **22**.

23 If you're using old machines as file or print servers in your business, consider switching to a mini PC. Save space and running costs in one fell swoop!

24 Whether you want to work in a different room or a different country,

having a PC that's easy to carry is always welcome.

25 One less considered environmental concern is noise output. Thanks to advanced cooling technologies and efficient mobile chips, your GEEKOM PC is likely to be much quieter than the desktop PC it replaces.

26 Being green isn't always about low power: it's also about efficiency. Buy a GEEKOM PC with AMD or Intel's latest chips and you will be amazed by the performance per watt.

27 Alan Chen, CEO of GEEKOM, has placed environmental consciousness as one of the company's most important goals.

28 Wherever you place a GEEKOM mini PC, you will always have easy access to a huge range of ports.

29 Because GEEKOM uses easy-to-source components, if you ever need to replace a part you should be able to do so easily.

30 There's one final reason: commitment. Throughout its 21 years of existence, GEEKOM has recognised the need for environmental sustainability. Its slogan is "Green Mini PC global leader," signifying not just a motto but also GEEKOM's commitment to users and the environment. ●



BELOW It's easy to replace the RAM, SSD and wireless chip in a GEEKOM mini PC



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GPU AMD RADEON Graphics
Case KOLINK Observatory HF MESH
O/S *NO OPERATING SYSTEM*
PSU BUILDER 500W PSU

Max (PRO2)



£979.99

CPU AMD RYZEN 5 7600X
Core 6 Cores - 12 Threads
Clock (4.7/5.3Ghz Turbo)
Mob ASUS PRIME B650M-A WIFI II
RAM ADATA 32GB DDR5 5600Mhz
M.2 TRANSCEND 1TB M.2 nVME
GPU NVIDIA RTX4060 TI 16GB
Case 1stPlayer D3-A aRGB - Black
O/S *NO OPERATING SYSTEM*
PSU CIT 700W PSU

UBER (PRO3)



£1159.99

CPU INTEL Core i5 14600K
Core 14 Cores - 20 Threads
Clock (2.6/5.3Ghz Turbo)
Mob ASROCK B760M-H/M.2
RAM ADATA 32GB DDR5 5600Mhz
M.2 ADATA 2TB S70 Blade M.2 nVME
GPU NVIDIA RTX4060 TI 16GB
Case GAMEMAX F15M MESH
O/S *NO OPERATING SYSTEM*
PSU BEQUIET 850W Gold PSU

Aurora RANGE

i3



[AUR1]

£629.99

CPU INTEL Core i3 14100F
Core 4 Cores - 8 Threads
Clock (3.5/4.7GHz)
Mob ASROCK B760M-H/M.2 DDR5
RAM ADATA 16GB DDR5 5600Mhz
M.2 TRANSCEND 1TB M.2 nVME
GPU NVIDIA RTX3050 8GB
Case GAMEMAX Abyss Mini RGB
O/S MICROSOFT Windows 10/11
PSU CIT 600W Bronze PSU

i5



[AUR2]

£999.99

CPU INTEL i5 14400F
Core 10 Cores - 16 Threads
Clock (Turbo 4.7Ghz)
Mob ASROCK B760M-H/M.2 DDR5
RAM CORSAIR 32GB DDR5 6000Mhz
M.2 ADATA 2TB M.2 NVMe
GPU NVIDIA RTX4060 8GB
Case CORSAIR iCUE 4000X
O/S MICROSOFT Windows 10/11
PSU CORSAIR 650W PSU

i7



[AUR3]

£1599.99

CPU INTEL Core i7 14700KF
Core 20 Cores - 28 Threads
Clock (3.4/5.6Ghz Turbo)
Mob ASUS PRIME Z790-P WIFI - DDR5
RAM CORSAIR 32GB DDR5 6000Mhz
M.2 ADATA 1TB S70 Blade M.2 nVME
GPU NVIDIA RTX4070 12GB
Case CORSAIR iCUE 4000X RGB
O/S MICROSOFT Windows 10/11
PSU CORSAIR 650W Gold PSU

www.palicomp.co.uk





KEEP YOUR PRIVATE MESSAGES PRIVATE

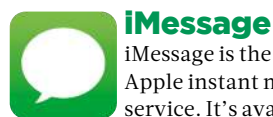
WhatsApp, iMessage, RCS, Signal... what's the safest way to communicate? Nik Rawlinson compares the major apps, and explores each one's key strengths and vital privacy settings



The Human Rights Act 1988 stipulates that “everyone has the right to respect for his private and family life, his home and his correspondence”. That means the government and state agencies can’t spy on your personal communications – at least, not without a court order.

Unfortunately, that doesn’t stop hackers and cybercriminals (or some governments). And the truth is that many of our communications are transmitted and stored insecurely. A malicious actor could intercept your messages in transit, or access them while they’re sitting on a provider’s servers – and then leak your personal information, forge messages using your identity or even blackmail you.

You can reduce the risk by using a secure messaging platform. The problem is that there are several options to choose from. To an extent your choice may be guided by what your colleagues are using, but it’s well worth understanding the strengths and weaknesses of each one, and how you can use them to keep your correspondence private.



iMessage

iMessage is the official Apple instant messaging service. It’s available in the Messages app for iOS, iPadOS and macOS, and at its launch in 2011 it was the first messaging service to use end-to-end encryption (E2EE) by default – meaning that your messages are encrypted on your device before being sent, and can only be decrypted by the recipient. Even though your communications are relayed through Apple’s servers, Apple can’t decode their content – and nor can any spies or hackers who might hypothetically intercept your messages.

To provide further security, if several devices are signed in to the same iMessage account – say, a Mac using an iCloud address, an iPad using a Gmail address and an iPhone using a phone number – then each one receives a uniquely encrypted message. The data received by any one of them would be a scrambled string if opened by one of the others.

In the latest versions of iOS, iPadOS, watchOS and macOS, as well as end-to-end encryption, iMessage includes a way to provide reassurance that the person you’re messaging really is who they say they are – as long as it’s someone who’s already saved in your contacts. The feature is called Contact Key Verification, and it works by generating a unique code that you can share with others to confirm your identity. To access it, tap Settings on your iPhone, followed by your name, then Contact Key



Verification. From here you can create a code that contacts can check to confirm they really are communicating with you (and you can do the same in return).

For most of its lifetime iMessage has used encryption built on the AES standard, but Apple has recently begun rolling out a new “post-quantum cryptographic protocol” called PQ3, which is designed to protect against the possibility of hackers using quantum computing methods to crack the encryption. PQ3 is available now in iOS and iPadOS 17.4, macOS 14.4 and watchOS 10.4; if you’re an iMessage user it’s recommended that you upgrade immediately, because while it’s not currently possible to decode iMessage encryption, there’s a possibility that

ABOVE Apple’s Messages app combines secure communications with regular SMS

hackers could gain access to archives of currently encrypted messages and decrypt them in the future, once the quantum technology is available.

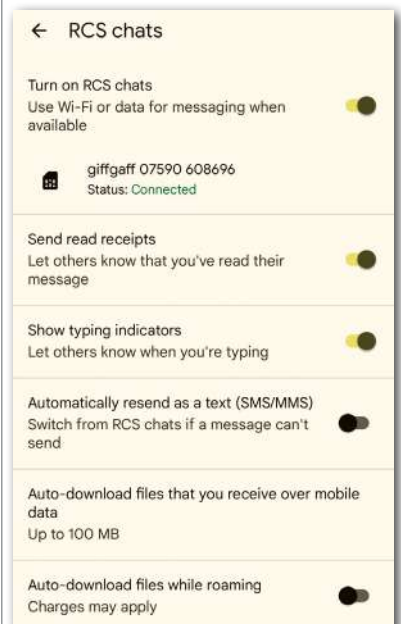
While iMessage has a lot going for it, it also comes with one major limitation: it only works on Apple devices. If you’re exchanging messages with an Android user, the Messages app will do so using the old unencrypted SMS and MMS protocols. To give a visual indication of which platform you’re using, iMessages are shown in blue bubbles within the Messages app, while regular unsecured SMS communications appear in green bubbles.

If you choose to use iMessage, therefore, keep an eye on the colour of the bubbles appearing in Messages – and if they’re not all blue, consider switching to another messaging service, such as Signal or WhatsApp, which allows users on all platforms to communicate securely.



RCS

RCS – short for Rich Communication Services – isn’t an app, but a standard that any messaging service can implement. Originally released in 2008 as an intended replacement for SMS and MMS, it supports smart features such as typing indicators, read receipts and file sharing, much like WhatsApp. Android has supported RCS for more than a decade, and while RCS isn’t natively encrypted, Google added its own E2EE layer (based on the Signal Protocol) in 2020. Encrypted RCS is now the default for all communications through the Google Messages app, so if you’re exchanging messages with an Android-using colleague, you should see a little padlock icon indicating that you’re protected.



Even though your communications are relayed through Apple’s servers, Apple can’t decode their content



Unfortunately, as with iMessage, RCS isn't universally supported. Apple has long resisted building it into its Messages app, preferring to stick to its proprietary messaging platform. And although the company recently announced it would be adding RCS support to the next full-point release of iOS and iPadOS, it doesn't plan to support Google's encryption system. That means RCS messages between Android and iOS users will still be insecure, and will appear in green bubbles like SMS and MMS messages.



Signal

Signal is one of the most popular secure messaging platforms, for several reasons. For one, it's not restricted to any platform – you can get the official app for Android, iOS, iPadOS, Windows, macOS and various flavours of Linux.

It also has all the features you'd expect of a modern messaging platform, including text, video and voice communication, voice note support and the ability to exchange files with your interlocutors. Everything uses E2EE by default, and the Signal Protocol is so well respected that it's used by Google for encrypting RCS messages and by WhatsApp.

The Signal app also adds some powerful features. You can verify the identity of the person you're communicating with by scanning a QR code on their phone, or comparing a 60-digit string of numbers with the same string displayed on your handset (the same technique used to confirm contacts in WhatsApp). To verify a contact in Signal, tap their icon, then tap View Safety Number and use your phone to scan the QR code that appears.

Signal messages can also be set to disappear after a set period, at which point they're deleted from both the sender's and recipient's handsets (a feature also offered by Telegram). Another neat feature is the ability to automatically blur faces in photos before they're sent; this makes it easy to share images of protests and other sensitive events without potentially exposing or incriminating anyone.

Although you need a phone number to initially register your account, it doesn't have to be the phone number of the device on which you're installing Signal; it could even be a landline or VoIP number if you prefer. And once you're on the platform, you can create and share a public username while keeping your number private.

Another feature we'd recommend Signal users look into is Registration Lock, which lets you assign a PIN to your user

With all these protections in place, Signal is an excellent defence against eavesdroppers

account, which must then be entered each time you log into a different device. This makes it very hard for anyone to impersonate you on the platform, while making it easy for you to hop onto a new device as needed – a particularly useful ability for anyone who frequently uses burner numbers or short-term VoIP accounts. Turn it on by tapping Settings in the Signal phone app, followed by Privacy, then Signal PIN. Then tap Registration Lock.

Signal even lets you send messages semi-anonymously with its "sealed sender" feature. This technology encrypts your own identity so that the Signal servers can deliver secure messages to their recipients without ever even knowing who they're from – and it's automatically enabled if your message recipient has you in their contacts list.

With all these protections in place, Signal is an excellent defence against hackers and eavesdroppers. And since the operator stores almost no identifiable information about its users, even if it were ever required to hand over user data to law-enforcement agencies, it's very unlikely it would be able to provide anything that could identify or incriminate any individual.



Telegram

The development of Telegram was inspired by a real-life incident. In 2011, its founder Pavel Durov (who also set up Russian social networking

site VK) rejected government demands to shut down the pages of anti-Kremlin election candidates; shortly afterwards, he received a visit at home from a Russian SWAT team. The experience made him acutely aware of the value of private, secure communications, and he began work on Telegram.

Today, the company that operates Telegram is officially headquartered in Dubai, but it works from undisclosed locations and has a complex organisational structure consisting of several shell companies, designed to make it difficult to pin down legally.

In use, Telegram is similar to WhatsApp and Signal. Originally launched for iOS and Android, it now has native clients for Windows, macOS and Linux, and can also be accessed through a browser at web.telegram.org. It supports text-based messaging between individuals and groups, transmission of images and other media, and live voice and video calls.

Perhaps surprisingly, while voice and video connections on Telegram are fully encrypted by default, chats aren't: regular messages are encrypted when they leave the user's handset, but are decrypted on Telegram's servers. To gain full security, users need to initiate a "Secret Chat", which does use end-to-end encryption. The messages in a secret chat can also be set to expire after a defined period, at which point the content is wiped from all participants' handsets, with no recovery possible.

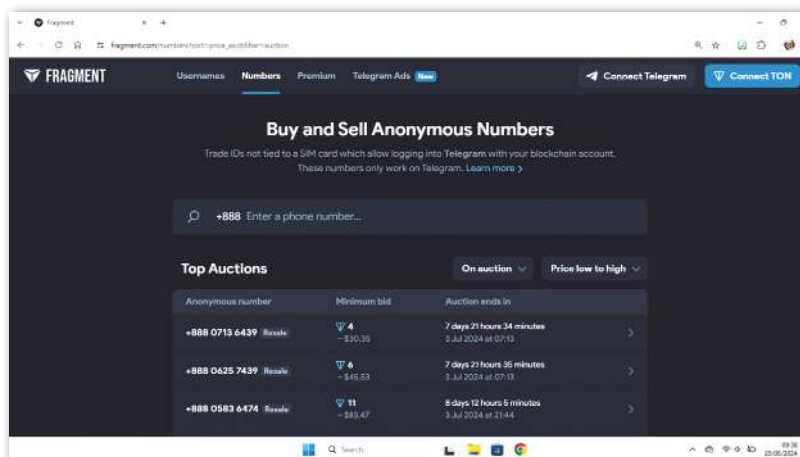
There are a few limitations with Telegram's secret chats. For maximum security the messages in a secret conversation can't be forwarded to other users, and they're locked to a device rather than a user account, so they won't synchronise to multiple devices if you're logged in to several at once.

It's also worth noting that regular chats can't be converted to Secret Chats in retrospect, so you'll need to initiate the feature at the beginning of your conversation if you want to use it. To do so, open Telegram, then find the contact with whom you want to communicate securely. Tap their avatar or icon at the top of the screen, then tap the "...More" button on the bar running across the middle of the screen; this reveals several options, one of which is Start Secret Chat.

You can sign up to Telegram with your mobile phone number, but if you don't want to associate any personal information with the service it's also possible to obtain a non-geographic number with the 888 country code through the Fragment platform (fragment.com/numbers), and sign up using that.

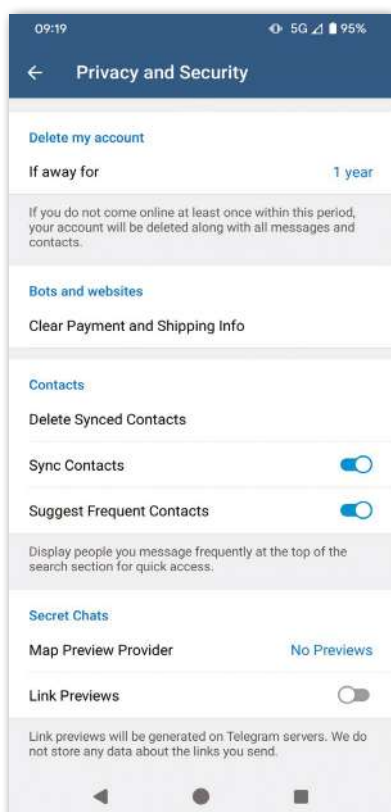
BELOW Signal can be used on almost any platform you can think of





LEFT Telegram includes a host of secure messaging features

BELOW LEFT You can buy an anonymous phone number to use with Telegram



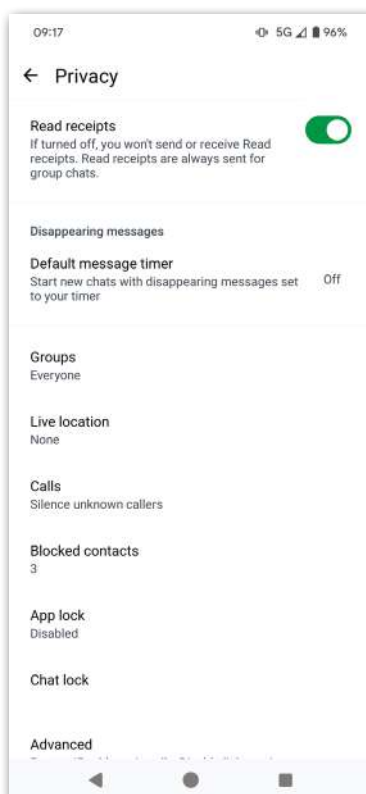
WhatsApp WhatsApp is the world's most popular non-native messaging platform, claiming two billion active users as of April 2024; for comparison, Telegram has "only" 900 million.

Notoriously, WhatsApp is owned by Meta, a company that hasn't always had a great reputation for protecting users' privacy and personal data. However, WhatsApp has been fully end-to-end encrypted since 2016; all messages and other data – such as photos, videos and voice notes – are scrambled at the point of creation, using the same encryption method as Signal, and only decrypted when they arrive at the recipient's device. This means that nobody who intercepts your messages in transit should be able to view their contents – including Mark Zuckerberg.

However, it's important to remember that once encrypted messages reach their destination, they can be read, stored and shared just like any other data. This is particularly pertinent in the case of WhatsApp, as many businesses use it for customer service; companies that you interact with on the platform can still process your messages in accordance with their own privacy and data-protection policies, and data relating to your interaction may be shared back to Meta.

This isn't necessarily as sinister as it may sound. It just means that, for example, a business might use the content of your message to determine whether you should be shown an ad on Facebook, or it could ask Meta to generate a response using AI. Meta sometimes uses the chats it processes to improve its own AI quality; look out for the tag "uses AI from Meta" below the company name, if you'd prefer that your data isn't used in this way.

There aren't many security settings to play with on WhatsApp – it's a highly secure platform by default. It doesn't store messages once they've been delivered, and doesn't even keep logs of delivered messages (undelivered messages may remain on its servers for 30 days, after which they're deleted). Another benefit of the Signal Protocol is that the encryption keys change regularly, so even if someone managed to extract them from your



BELOW WhatsApp is the most popular messaging platform in the world

device, the compromised keys couldn't be used to decrypt previously transmitted messages.

If you have any doubts about who you're talking to, there is a way for you and your correspondents to view and compare your encryption keys. To do so, open a chat on your phone, then tap your contact's name to open the contact information screen. Now tap Encryption to reveal a QR code and a 60-digit key. If you're in the same place as your colleague you can each scan the code on each other's phone to verify that it's valid; otherwise you can share copies of your 60-digit keys to confirm that they match.

Picking a platform

While each of the mainstream messaging platforms offers some sort of encryption, it's clear that not all platforms are equally secure by default, or don't necessarily offer protection for all communications. It's also vital to remember that E2EE is only as secure as the person you're sending your messages to. We've all seen screenshots of politicians' WhatsApp groups, which have been leaked to the press and shared with the public.

As well as choosing an appropriate platform and implementing its security options as appropriate, therefore, remain mindful of the low-tech ways your words can come back to haunt you. No matter how much you may trust the platform, it's safest to avoid saying anything in a private chat that you wouldn't want to be made public. ●





Give your PC new life with ChromeOS Flex

Want to bring an old computer back to life, or set up a simple, secure productivity environment? **Darien Graham-Smith** tries out Google's free ChromeOS Flex platform

Most of us have old computers knocking about that still work perfectly well, but which struggle with the latest versions of Windows and desktop applications. Google's lightweight ChromeOS could give such systems a new lease of life: it's designed to run snappily on low-power hardware, and it can't be beaten for simplicity and security – which means it's also an ideal choice if you're setting up a computer for your kids, or donating one to your parents.

And let's be clear, this is no hack. When ChromeOS was first released it was exclusively available on Chromebook and Chromebox systems (remember them?), but 2022 saw the introduction of the ChromeOS Flex edition, which you can download for free and run on any Intel-based PC or Mac with Google's blessing. The installation is mostly driven by simple click-through wizards, and depending on the speed of your computer, your internet connection and your USB flash drive, the whole setup process can easily take less than 20 minutes.

What can't it do?

Before you try out ChromeOS Flex, some caveats. First, the OS isn't guaranteed to run on every computer: Google maintains a list of certified systems at tinyurl.com/36oflexmodels along with an end-of-support date for each one. This doesn't mean that you can't install it on other models, or that it will stop working after the published date, but if you do hit compatibility problems on unsupported hardware, don't expect a whole lot of help from Google.

Also note that not all ChromeOS features are available in the free Flex edition. In particular, Flex doesn't support Android apps. On most custom-built Chromebooks you can download mobile apps from Google Play, making it a great platform for casual gaming as well as productivity, but with ChromeOS Flex that's not possible.

Still, this isn't as big a restriction as it might initially seem. There's no shortage of web-based games to pass the time, plus there's a huge range of productivity tools that will run in the browser, including image-editing programs such as Adobe Express and graphic design packages like Canva. And if you want the full power of native applications, it's possible to install Linux apps in ChromeOS Flex, as we'll discuss below.

Another feature not supported in ChromeOS Flex is Windows virtualisation. Some business-oriented Chromebooks come with

the Parallels hypervisor preinstalled, allowing them to run Windows applications in a virtual machine alongside native ChromeOS apps, but it's not available on ChromeOS Flex.

Security smarts

These exclusions may well be to do with the security of the platform. All certified Chromebooks come with Google's H1 security chip, which verifies that the hardware and software haven't been compromised; when you install ChromeOS Flex on hardware that was designed for another OS, that's naturally missing. Older laptops may also be lacking a TPM for hardware-backed encryption, but this isn't a disaster, as ChromeOS Flex can still fall back on software-based protection.

Indeed, ChromeOS Flex as a whole remains a very secure operating system. It uses the same robust architecture as regular ChromeOS, with all web pages and apps running in isolated sandboxes, and most user data stored securely in the cloud in encrypted form. The OS also automatically updates itself every few weeks, and its bootloader uses the same Secure Boot technology as Windows – so if the startup files have been tampered with, the computer won't start up at all.

As well as omitting a few features, ChromeOS Flex doesn't guarantee to support every component and connector that might be built into your laptop. For a typical Chromebook role this shouldn't be a problem – all standard USB ports and video outputs will work fine, and if your laptop has a touchscreen then that should be recognised, too. However, Thunderbolt isn't supported, webcams might or might not work, and most biometric sensors simply won't function.

Despite a few necessary accommodations, you can generally expect a slick experience with ChromeOS Flex. Indeed, thanks to its minimal hardware requirements it will fly along on more or less any laptop that was originally sold with Windows.

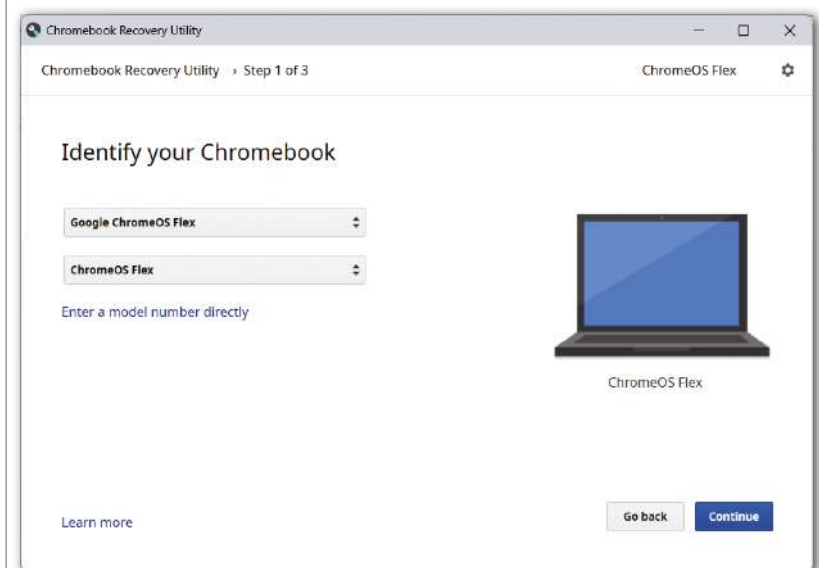
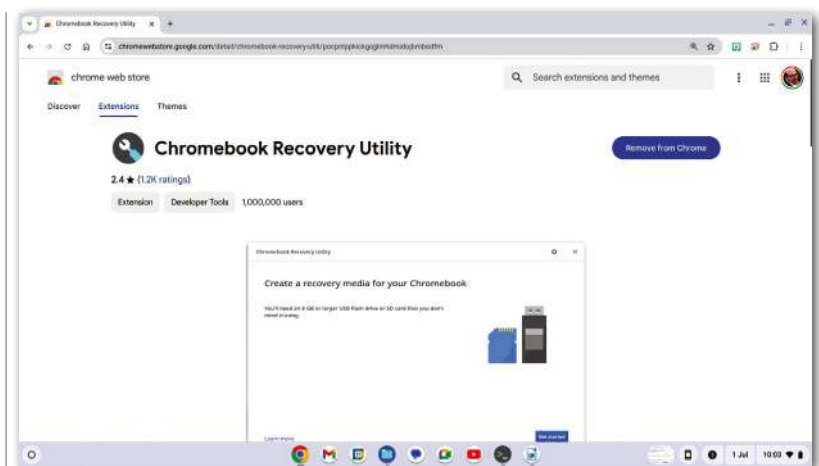
Preparing to install ChromeOS Flex

Getting set up with ChromeOS Flex is very simple – the only thing you need is a USB flash drive with a capacity of at least 8GB. Be aware that the ChromeOS setup routine will overwrite the contents of this flash drive with the installation files, so back up anything valuable before you start.

Note, too, that once you launch the ChromeOS installer it will completely wipe the old OS and

RIGHT You'll first need to search the Chrome Web Store for "Chromebook Recovery Utility"

RIGHT When you're asked to select a manufacturer, choose "Google ChromeOS Flex"



Getting set up with ChromeOS Flex is simple – the only thing you need is a USB flash drive with a capacity of at least 8GB

files from your target computer, replacing them with a clean, fresh ChromeOS installation. There's no dual-boot option, nor any easy way of installing ChromeOS Flex inside a virtual machine. Again, therefore, be sure to back up anything you might want to keep before proceeding.

If you're in two minds about ChromeOS Flex, it is possible to try it out as a "live" environment, running from your USB flash drive – but performance will likely be held back by running the OS off your USB drive, and you won't get certain conveniences such as automatic OS updates. We certainly wouldn't recommend using ChromeOS in this way on a long-term basis.

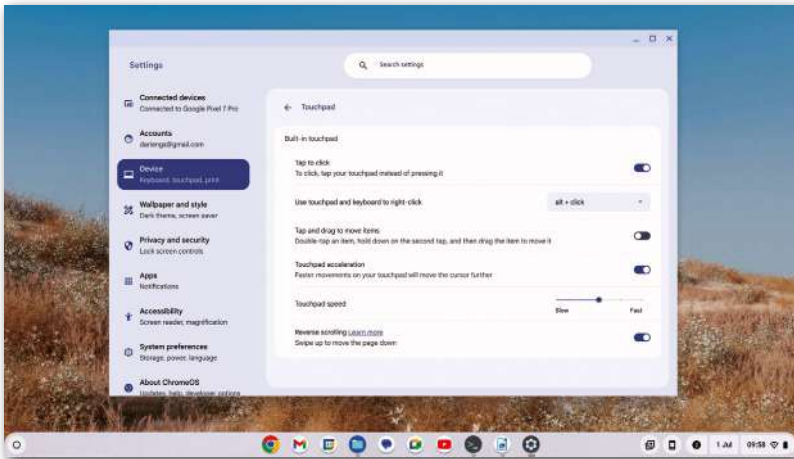
While there's no rollback option for ChromeOS Flex, if you install it and later decide you want to go back

to Windows, you can download installation files for Windows 10 and 11 from the Microsoft website (see tinyurl.com/36oflexmedia) and reactivate your hardware without needing a product key.

Getting and running the installer

You can create the ChromeOS Flex installation media on any Windows or macOS computer – or, indeed, on a Chromebook, should you already own one. Rather than offering native tools for different platforms, Google supplies the requisite utility in the form of a Chrome extension. This means you'll need to be using the Chrome browser to get started, so it's hardly a dealbreaker.

The creation process is simple, but not wholly intuitive: rather than creating a custom installer for ChromeOS Flex, Google has shoe-horned it into the existing recovery process for ChromeOS systems. To start with you'll need to search the Chrome Web Store for "Chromebook Recovery Utility"; add this extension to your browser, then launch it. You'll see a welcome window open, with a single button labelled "Get started".



Clicking on this takes you to a page that prompts you to enter the model number of the Chromebook you want to recover. Since that obviously doesn't apply in this situation, click "Select a model from a list" to bring up two dropdown menus; under "Select a manufacturer", choose "Google ChromeOS Flex", and under "Select a product", choose "ChromeOS Flex".

The rest of the procedure is self-explanatory; you'll be prompted to select your target USB device, and warned that it will be wiped. It will then download the latest ChromeOS files, and set up your USB drive as a bootable ChromeOS installer.

You now simply need to restart your target PC and boot it from the

ABOVE You can invert the touchpad scrolling direction, so you can drag up or down with two fingers and see onscreen content move in the direction you expect

click on this to open the localisation page, where you can switch to UK English and a UK keyboard layout. Cutely, there's also the option of UK English with Oxford spelling – a peculiar variant which we'll leave you to investigate for yourself.

Once you've chosen your region settings you'll be asked whether you want to install the OS or "Try it first". As we've discussed, you can by all means give the latter option a whirl, but for now let's assume you're installing ChromeOS Flex to your hard

disk. Confirm this choice, then wait a few minutes while the installer does its work.

When it's finished, you'll be prompted to connect to a wireless network, and asked whether

you want to set up ChromeOS for personal use, for a child or for work. "Personal use" is normally the right answer, but it's good to know that you can set up a ChromeOS Flex machine with parental controls, connect it to a school account or enrol it into a corporate Google Workspace account (see "Managing ChromeOS Flex for business", opposite). In the next step you can also choose whether to use a unique password for this Chromebook, for maximum security, or log on with your regular Google password.

If you have an Android phone registered to your Google account, you'll now be invited to connect to it, to enable features such as Smart Lock – automatic unlocking when your phone is nearby – and Wi-Fi sync, so your ChromeOS Flex device automatically gains access to wireless networks that you've

Run office apps on ChromeOS Flex

ChromeOS Flex is a capable operating system, but its lack of support for Android apps does hold it back. That applies particularly if you want to use Microsoft Office; since the native editions of Word, Excel and so forth can't be installed on Flex, you're limited to the more basic web equivalents.

There is, however, a way to get a fully featured office suite onto your ChromeOS Flex computer. Although Flex doesn't support Windows virtualisation, it can host a Debian-based Linux environment, into which you can install the free LibreOffice suite. You can also connect your OneDrive account to ChromeOS, to easily share files with other computers running Office – you'll find the option in the Settings app, under System preferences.

The Linux environment is disabled by default. To enable it, open the Settings app, scroll down and click on About ChromeOS, find the "Linux development environment" option and click "Set up". Then click through the process of setting your Linux username and deciding how much hard disk space to allocate to your Linux system

In a few minutes you should see a Linux terminal window open. From here you can install LibreOffice using the standard APT file manager. First, make sure your package list and operating system are up to date by entering these two lines:

```
sudo apt update
sudo apt upgrade -y
```

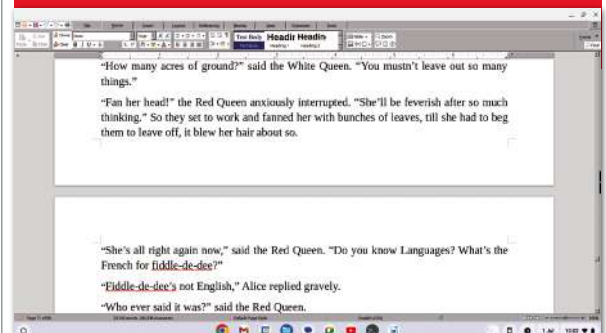
Then enter:

```
sudo apt install libreoffice
```

The installer will warn you that this will take up more than a gigabyte of space on your hard disk; hit Return to continue with the installation, then wait a few minutes while the necessary files are downloaded and installed. When the process is finished, you'll be returned to the shell prompt; tap the Search button and you should now see a new folder labelled "Linux apps" containing shortcuts to the various LibreOffice applications.

There's just one last bit of configuration you'll probably want to do. By default, the Linux environment is fully containerised, and can't access files stored in the main ChromeOS Flex filing system. To give it access, open the ChromeOS Files application, right-click on a folder that you want to be accessible, and select "Share with Linux". You can do this with as many folders as you want, including locations inside Google Drive or OneDrive; all items shared in this way can be accessed in LibreOffice and other Linux apps by navigating to /mnt/chromeos.

Aside from LibreOffice, there's a whole galaxy of Linux apps that you can install on your ChromeOS Flex laptop to make it more useful. And you're not limited to using the APT package manager; you can also use pre-packaged installers in the .deb format – just download and double-click to launch them.



In just a few seconds you should be greeted by a screen declaring 'Welcome to ChromeOS Flex'

USB drive. On a Windows machine the easiest way to do this is to open the Windows Settings app, go into System | Recovery and find the setting labelled "Advanced startup: Restart your device to change startup settings, including starting from a disc or USB drive". Hit the corresponding "Restart now" button to reboot the computer; in a moment or two it should come back up with a big blue startup options screen. Select "Use a device" to boot from your USB drive. After you've installed ChromeOS Flex you won't need to do this again, as the computer will boot from the hard disk by default.

Completing the installation

It's plain sailing from this point. In just a few seconds you should be greeted by a screen declaring "Welcome to ChromeOS Flex". This will show your default region as US;

You can set up a ChromeOS Flex machine with parental controls or enrol it into a Google Workspace account

connected to from your phone, and vice versa. You can also enable Instant Tethering, which allows ChromeOS to automatically connect to the internet through your phone when there's no Wi-Fi available.

The final page is headed "Choose more features to set up", with options to customise the display scaling and choose between dark and light interface themes. Pleasingly, there's an option to invert the touchpad scrolling direction, so you can drag up or down with two fingers and see onscreen content move in the direction you expect – whichever way that might be.

With that done, you're dropped onto the ChromeOS desktop, ready to start using your new OS. There are just a few final bits of configuration you might want to look at. One is the keyboard; Chromebooks use a slightly idiosyncratic keyboard layout, with action keys in place of the familiar function keys, and a Search key (officially called the "Everything Button") where you might expect Caps Lock. Some also have a dedicated Assistant key, to bring up the Google Assistant for a quick query.

If you're running ChromeOS Flex on a laptop that was designed for Windows, the Windows key will serve as the Search button, while various key combinations take the place of the action buttons; you can find a complete set of shortcuts at tinyurl.com/360flexshort. If you open the Settings app on your ChromeOS Flex system, then navigate to Device and click on "Keyboard and inputs" you can customise the behaviour of various keys.

Note, too, that ChromeOS doesn't support right-clicking on a touchpad; instead, you can click while holding down the Alt or Search keys to bring up contextual menus. To enable this, again navigate to Device in the ChromeOS Settings app, then click on "Touchpad" and select your choice of right-click action from the dropdown menu.

Now all that remains is to start getting productive. Visit tinyurl.com/360flextips for Google's official tips on getting started, and explore the dropdown menus at the top of the page to find recommendations for top apps, useful settings and more. ●

RIGHT ChromeOS Flex doesn't support Android apps, but there are lots of web-based games you can play

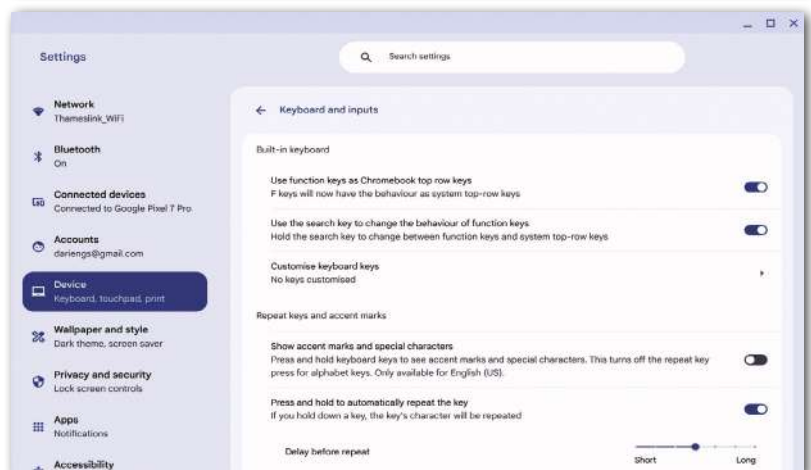
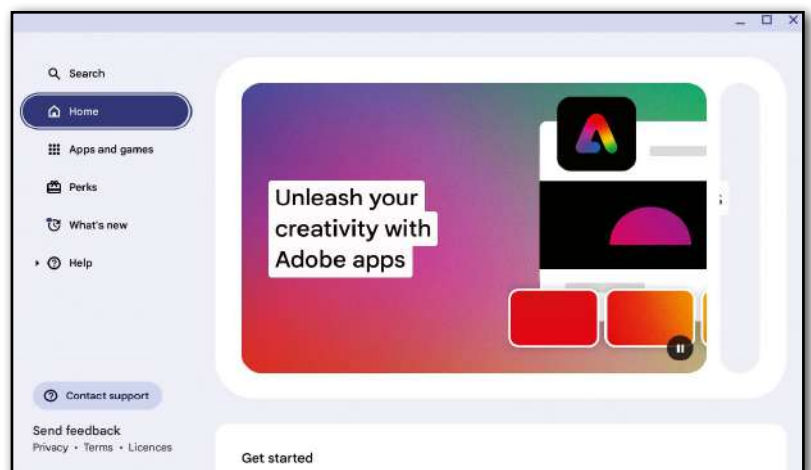
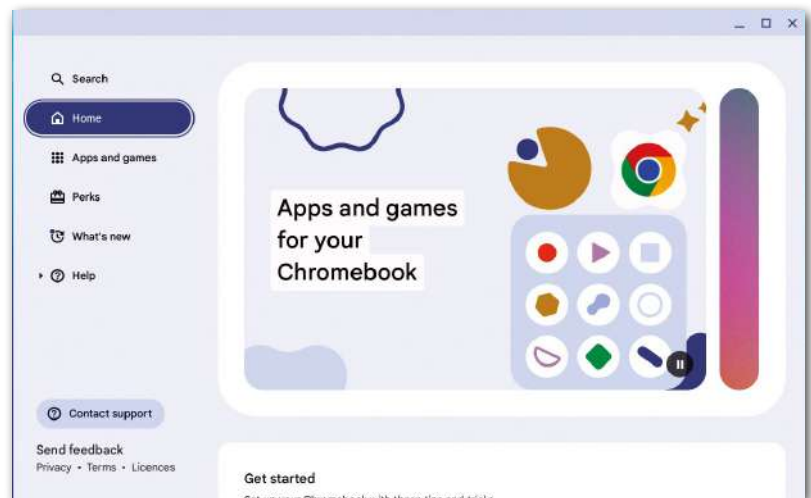
RIGHT Productivity tools that will run in a browser include Adobe Express

RIGHT Chromebooks have action keys in place of function keys

Managing ChromeOS Flex for businesses

When you first install ChromeOS Flex you'll see the option of signing into a managed Workspace account; alternatively, you can switch later by selecting "Add person" from the login screen. This makes ChromeOS Flex a great option for small businesses on tight budgets, giving them a free and easy way to recycle old laptops into perfectly usable employee computers, with low overheads for support and security.

However, it's important to know that devices running a standard ChromeOS Flex installation can't be remotely managed from the Google Workspace Admin console. To add this capability you'll need the Chrome Enterprise Upgrade; Google offers a 30-day free trial for up to 50 devices, after which it costs £40 per device per year. That's not quite as price-competitive as free, but it's still a modest outlay compared to buying all-new Chromebooks for your team – and it's a lot cheaper than Microsoft's Windows Enterprise Cloud solutions, which start at £345 per year.



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Microsoft Surface Laptop, 7th Edition

The poster child for Copilot+ PCs matches stylish looks with fast speeds and staggering battery life

SCORE ★★★★★

PRICE As reviewed, £1,791 (£2,149 inc VAT) from microsoft.com

Microsoft has toyed with Arm-based laptops for years, starting with the Surface RT back in 2012 and more recently the Surface Pro X (see issue 328, p91). But those were toes in the water. With the launch of Copilot+ PCs, which need at least 40 TOPS of AI processing power, it's jumped right in and declared that the water is divine, switching both its headline laptops to the Arm platform.

We start with the Surface Laptop – fans of the Surface Pro should turn to p52 – as both its 13.8in and 15in models include Qualcomm Snapdragon X chips. The bigger version, which I tested, only ships with the 12-core Elite X1E-80-100, but the cheapest 13.8in Surface Laptop includes the 10-core Plus X1P-64-100, alongside 16GB of RAM and a 256GB SSD.

That costs £1,049 inc VAT, and is good value if you can live with such

little storage, but most people should stump up the extra £200 for the 512GB SSD. This also means you can choose from the full range of colour finishes: Dune (bronze), Sapphire (light blue) and Black. Microsoft uses the same playbook with the 15in model's pricing, with the bottom model shipping with 16GB of RAM and a 256GB SSD for £1,349 but only available in Platinum (grey).

For my testing, Microsoft sent in the top spec with 32GB of RAM and a 1TB SSD, which costs a juicy £2,149. You can save £400 by cutting the RAM to 16GB.

Most improved

This is the perfect place to mention that Microsoft has done an amazing job to make its Surface laptops easier to upgrade and

ABOVE The impressive Surface Laptop 7th Edition is available in four classy finishes

repair. It ships with a detailed guide, complete with part numbers for every replaceable component, and earned 8/10 from iFixit for repairability. The bad news is that you can't upgrade the RAM as this is integrated, but you can easily replace the M.2 SSD.

The only downside is that it's a shorter 2230 format, not the standard 2280, and despite the advantage of high-density chips in my 1TB sample it returned moderate speeds in our sequential transfer tests: 3,674MB/sec reads, 3,026MB/sec writes. I'm used

BELOW The display adds to the laptop's feel of luxury and style

to seeing almost twice those rates in recent machines.

It's ludicrously easy to get inside this laptop, so long as you have a Torx T5 screwdriver. Only four screws stand in your way, all kept out of sight by rubber feet that clip on and off without adhesive. Anyone who remembers the glue-riddled early Surface machines will be delighted by the change.



Microsoft also ticks all the boxes when it comes to the use of recycled materials, with 67% of the chassis made from recycled aluminium alloy. It has also committed to be “carbon negative, water positive, and achieve zero waste by 2030”, but that does include a controversial carbon-credit deal with a petro-chemical company, so don’t get too swept away.

The Copilot+ PC difference

Last month, in the Asus Vivobook S 15 review (see issue 359, p52), I went into great detail on what Copilot+ PCs offer and won’t repeat myself here. The Surface Laptop’s big advantage over the Asus is a touchscreen, which makes it easier to sketch ideas if you wish to use the Cocreator feature in Paint that uses AI to enhance your drawings. It works okay (not brilliantly) now but I suspect it will continue to improve.

Otherwise, the current AI pickings are slim. Enhanced webcam effects make this a brilliant choice for web calls, but fundamentally it’s more important to have a top-quality webcam. In good light the Surface Laptop certainly falls into that category, less so in low light. You can download an app called Camo Studio via the Windows Store that gives you finer control for a “studio experience” and the ability to add emoji hands.

We’re still waiting for Recall to roll out on Copilot+ PCs – this will allow you to ask your computer to find, say, the presentation about cats you created last week – but the AI features feel like a thin scraping of jam now with hopes of dollops tomorrow.

Nippy performer

Rather than on-chip AI, the biggest revelation with this first wave of Copilot+ PCs is the performance of Qualcomm’s chips. The top-end, 12-core Elite X1E 80 100 on test here stretched its legs in Geekbench to superb effect, scoring 14,285 in the multicore section and a similarly excellent 2,818 in the single-core tests. It’s also strong in Cinebench 2024, with 918 and 120 in the multicore and single-core sections respectively.

As with the Asus Vivobook I tested last month, I was impressed by the Snapdragon’s performance in x86 apps where it relies on the Prism translator. Anyone expecting a sluggish experience will be surprised by how nippy non-native apps are, and on this occasion I didn’t experience a single crash.

What you can’t expect is brilliant gaming performance. I tested the Surface Laptop in *Dirt 5* and *Shadow of the Tomb Raider*, and the only time I went above 30fps at 1080p was in the latter with the lowest graphics settings when it averaged 35fps. *Dirt 5*, which

GEEKBENCH 6 (SINGLE-CORE)

Apple MacBook Air 13 M3 M3 8-core, 10-core GPU, 16GB RAM	3,082
Samsung Galaxy Book4 Edge X1E-84-100, Adreno GPU, 16GB RAM	2,897
Microsoft Surface Laptop 7 X1E-80-100, Adreno GPU, 16GB RAM	2,818
Microsoft Surface Pro 11 X1E-80-100, Adreno GPU, 16GB RAM	2,813
Lenovo ThinkPad T14s G6 X1E-78-100, Adreno GPU, 32GB RAM	2,447
Asus Vivobook S 15 OLED X1E-78-100, Adreno GPU, 16GB RAM	2,432

HIGHER IS BETTER

3DMARK TIME SPY

Samsung Galaxy Book4 Edge X1E-84-100, Adreno GPU, 16GB RAM	2,191
Asus Vivobook S 15 OLED X1E-78-100, Adreno GPU, 16GB RAM	1,899
Microsoft Surface Pro 11 X1E-80-100, Adreno GPU, 16GB RAM	1,887
Microsoft Surface Laptop 7 X1E-80-100, Adreno GPU, 16GB RAM	1,880
Lenovo ThinkPad T14s G6 X1E-78-100, Adreno GPU, 32GB RAM	1,849
Apple MacBook Air 13 M3 M3 8-core, 10-core GPU, 16GB RAM	Not tested

HIGHER IS BETTER

GEEKBENCH 6 (MULTICORE)

Samsung Galaxy Book4 Edge X1E-84-100, Adreno GPU, 16GB RAM	15,819
Lenovo ThinkPad T14s G6 X1E-78-100, Adreno GPU, 32GB RAM	14,530
Microsoft Surface Pro 11 X1E-80-100, Adreno GPU, 16GB RAM	14,432
Microsoft Surface Laptop 7 X1E-80-100, Adreno GPU, 16GB RAM	14,285
Asus Vivobook S 15 OLED X1E-78-100, Adreno GPU, 16GB RAM	14,263
Apple MacBook Air 13 M3 M3 8-core, 10-core GPU, 16GB RAM	12,087

HIGHER IS BETTER

BATTERY LIFE (LIGHT USE)

Lenovo ThinkPad T14s G6 X1E-78-100, Adreno GPU, 32GB RAM	23hrs 29mins
Microsoft Surface Laptop 7 X1E-80-100, Adreno GPU, 16GB RAM	15hrs 59mins
Apple MacBook Air 13 M3 M3 8-core, 10-core GPU, 16GB RAM	15hrs 13mins
Asus Vivobook S 15 OLED X1E-78-100, Adreno GPU, 16GB RAM	12hrs 49mins
Microsoft Surface Pro 11 X1E-80-100, Adreno GPU, 16GB RAM	12hrs 17mins
Samsung Galaxy Book4 Edge X1E-84-100, Adreno GPU, 16GB RAM	12hrs 14mins

HIGHER IS BETTER

is far from a demanding game, hit 27fps with Low settings at 1080p, reaching a playable 37fps at 1,080 x 720.

Great battery

The Surface Laptop’s best showing came in our battery tests, where it cranked out a succession of superb results. In PCMark’s Office test, 15hrs 59mins; video playback, 18hrs 8mins; idling, 25hrs 19mins. Admittedly those results were with the screen locked at 150cd/m², but considering that the Surface only includes a 66Wh battery that’s an astounding result.

My sole word of warning to daily commuters is that you will feel this laptop’s 1.7kg weight, so if you think you can live with a 13.8in screen then consider the smaller version. It weighs 1.3kg, and will probably give you a couple hours less battery life as it includes a 54Wh unit, but otherwise you’re giving up very little: connectivity is well covered in both laptops, with Wi-Fi 7, Bluetooth 5.4, two USB-C 4 ports, a single USB-A 3.2 Gen 1 port and a 3.5mm headphone jack (plus the Surface Connect port for charging and docking stations). The only port exclusive to the larger machine is a microSDXC card reader.

The screen resolution drops down a fraction, too, but you’ll still enjoy the 3:2 aspect ratio and a pixel density of 200ppi. You can choose between two colour modes, with Vivid giving a wider gamut (95% of DCI-P3) while sRGB locks it down to that space. It also delivers delicious whites, while a sensor means it can adapt the colour and brightness depending on ambient light levels.

“Rather than on-chip AI, the biggest revelation with this first wave of Copilot+ PCs is the performance of Qualcomm’s chips”



ABOVE Connectivity includes two USB-C 4 ports and a single USB-A 3.2 Gen 1 port

Delivered with style

This sense of luxury and style is also helped by a sleek 18.3mm profile with the lid closed. And I enjoyed a frisson of pleasure – the same you get when you close a luxury car door – when

lowering the lid, which almost purrs closed and lifts with ease even with a single finger. There’s a lot of attention to detail here.

I still think Microsoft can improve the keyboard.

It has large keys, separated cursor buttons and a chunky Enter key, but I would like more cushioning to echo the rest of this laptop’s fine airs – and to match the excellent, glass-coated haptic touchpad.

With one of the finest sets of speakers you’ll find on a laptop, Microsoft gets little wrong here. I have my usual criticisms about value for money – especially when you consider the one-year warranty – but can’t deny the quality on offer. I have no hesitation recommending it to individual buyers, and when Microsoft introduces its business line later this year it should also be added to any executive’s wish list. **TIM DANTON**

SPECIFICATIONS

12-core Qualcomm Snapdragon X1E-80-100 SoC • Qualcomm Adreno graphics • 32GB LPDDR5X-7467 RAM • 15in 120Hz IPS touchscreen, 2,496 x 1,664 resolution • 1TB M.2 PCI-E Gen4 SSD • Wi-Fi 7 • Bluetooth 5.4 • 1080p IR webcam • Surface Connect port • 2 x USB-C 4 • USB-A 3.2 Gen 1 • 3.5mm combo jack • microSDXC card reader • 66Wh battery • Windows 11 Home • 329 x 239 x 18.3mm (WDH) • 1.7kg • 1yr C&R warranty



Microsoft Surface Pro, 11th Edition

A magnificent OLED panel and Snapdragon X chips make this the best iteration yet of Microsoft's tablet

SCORE ★★★★★

PRICE As reviewed, without keyboard, £1,291 (£1,549 inc VAT) from microsoft.com

Microsoft is making a decisive statement with its new 2-in-1. The 2024 Surface Pro (aka the 11th Edition) isn't the first Surface to use an ARM processor, but with Qualcomm's Snapdragon X chips and more compatible apps than ever, it's a mainstream rival to laptops with Intel and AMD's x86 chips inside.

It comes in two configurations. The first includes the 10-core Snapdragon X Plus processor and a regular LCD panel; that starts at £1,049 inc VAT, and includes 256GB of storage and 16GB of RAM. The second costs from £1,549, but you get a 512GB SSD, a 12-core Snapdragon X Elite chip and, for the first time in a Surface Pro, an OLED screen.

It's a 2,880 x 1,920 display with a 3:2 aspect ratio and a refresh rate of up to 120Hz, and it's gorgeous; when I watched the trailer for Brad Pitt's *F1*, grass patches alongside the track popped against the cement. It's bright, too, peaking at 564cd/m², while its colour reproduction covers the DCI-P3 gamut and 15% beyond.

As ever with the Surface Pro, you must pay extra for the keyboard and stylus. I was sent the £439 Surface Pro Flex Keyboard with Slim Pen 2 combo, but £280 buys you the plainer Surface

Pro Keyboard. The Slim Pen 2 isn't new, but the keyboard now works over Bluetooth so doesn't need to be physically connected.

The chiclet keys feel surprisingly deep and crisp. There's bounce, but I hit 122 words per minute with 98% accuracy on the Monkeytype test, which is better than I manage on most traditional laptops. The Flex keyboard also includes a wide haptic touchpad, which works extremely well.

Even with the keyboard attached, this is an extremely portable setup, and the only big sacrifice you make over laptops are ports: there are two USB-C 4 connectors, the Surface Connect port and that's it. There's no 3.5mm headphone jack, and no USB-A port.

Compact dimensions also mean Microsoft is limited to a 53Wh battery, but it lasted for a respectable 12hrs 17mins in our light-use test. That was with the Snapdragon X Elite X1E-80-100 inside, the second fastest of Qualcomm's chips. Paired with 16GB of RAM, it returned a single-core score of 2,813 in Geekbench 6 and a multicore result of 14,432. The latter is roughly 20% faster than Apple's M3, although that chip returns over 3,000 in the single-core test.

Our test machine included a speedy 512GB SSD, and it's easy to upgrade thanks to a small door on the rear, behind the kickstand. Removing the door doesn't even require any tools: you simply push down on a small dimple and it pops off. The SSD is held down by a Torx screw, but the biggest limitation is that Microsoft uses

ABOVE For the first time, the Surface Pro comes with an OLED panel option

LEFT The keyboard and stylus are still optional extras – but also great quality

"It's a 2,880 x 1,920 display with a 3:2 aspect ratio and a refresh rate of up to 120Hz, but more to the point it's gorgeous"

BELOW The new Flex keyboard works over Bluetooth

small 2230 SSDs rather than the more standard 2280 format. Despite the ease of access, Microsoft says in the fine print that the Surface Pro's SSD should be replaced only by an "authorised technician following Microsoft provided instructions".

The Surface Pro comes with a one-year warranty, but Microsoft Complete cover extends that to up to four years (£303) and includes accidental damage.

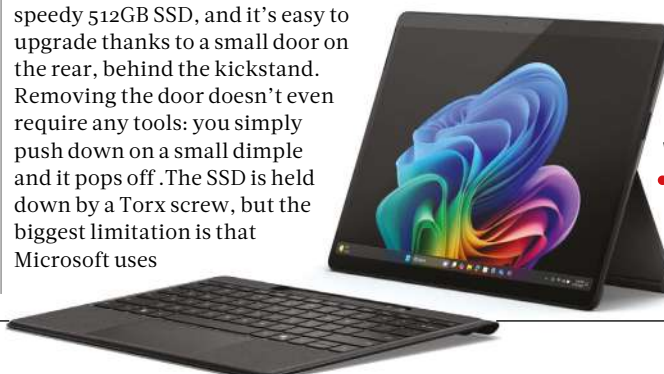
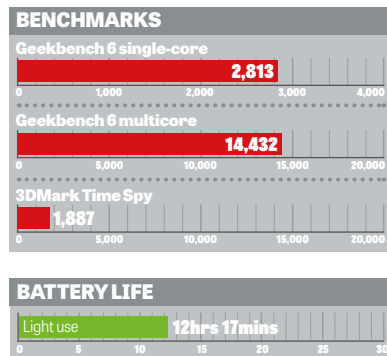
Everything else about the Surface Pro is as you would expect from previous versions. The speakers are great for such a sleek machine, the 1440p webcam delivers excellent results for web calls – helped by the AI features if you like effects such as

background blur and auto framing – while the 10MP rear camera is fine for snaps but won't replace your phone's camera.

The same criticisms we've always laid at the Surface Pro range in terms of value for money still hold – especially having to pay extra for the keyboard and stylus – but more important here is that this Surface Pro nails Microsoft's original vision: a portable, slim PC with desktop-matching speed and all-day battery life. **ANDREW FREEDMAN**

SPECIFICATIONS

12-core Qualcomm Snapdragon X1E-80-100 SoC • Qualcomm Adreno graphics • 16GB LPDDR5X RAM • 13in 120Hz OLED touchscreen, 2,880 x 1,920 resolution • 512GB M.2 PCI-E Gen4 SSD • Wi-Fi 7 • Bluetooth 5.4 • 1440p IR webcam • 10MP rear camera • SurfaceConnect keyboard connector • 2x USB-C 4 ports • 53Wh battery • Windows 11 Home • 287 x 209 x 9.3mm (WDH, tablet only) • 895g • 1yr C&R warranty



Samsung Galaxy Book4 Edge 16in

Currently your only choice if you seek a 16in Copilot+ PC, but it has many things in its favour beyond uniqueness

SCORE ★★★★★

PRICE 1TB, £1,416 (£1,699 inc VAT)
from [samsung.com](https://www.samsung.com)



The Book4 Edge is unique among Copilot+ PCs for one reason: its 16in screen. It's odd that others concentrate on 14in and 15in designs, because if you need to get serious work done then every inch counts. And who doesn't enjoy a big screen when watching films?

I would say gaming as well, but as with all other laptops based on Qualcomm's Snapdragon X chips the Book4 Edge isn't a good choice for gamers. That's reflected in its 29fps average in *Dirt 5* and 33fps in *Shadow of the Tomb Raider*. And that was at 1200p with low settings.

Those results are higher than rival Copilot+ PCs I've tested, however, thanks to Samsung choosing the top-end Snapdragon X1E-84-100 chip. Together with 16GB of RAM, it powered the Book4 Edge to a chart-topping 15,819 in Geekbench 6's multicore section. More anecdotally, I loved using this laptop for its sheer snappiness.

In CrystalDiskMark its scores were more mixed, with decent 3,676MB/sec sequential reads but poor 594MB/sec writes – that's because it uses UFS 4 storage (designed for phones) rather than NVMe. It isn't a reason to avoid this laptop, but it means that you can't

upgrade or replace the storage as it's integrated onto the motherboard.

Accessing the Edge's innards is easy – four crosshead screws, hidden under rubber feet, are all that stand in your way – but Samsung hides the motherboard under a thin black sheet, and with no service manual available I decided not to risk trying to remove it. The main thing I noted were two fans, which is another reason why this is such a speedy computer: head into the Galaxy Book Experience app and you can switch on High Performance mode and they'll activate more often, but generally it's whisper-quiet.

Four speakers (two 5W woofers, two 2W tweeters) add audio heft in films, and I loved watching Netflix's *Kleo* on this 16in panel. It peaks at 400cd/m² in normal use, but activate HDR mode and it will give a minor but welcome boost to 500cd/m² in supported video. Colour coverage is superb, stretching 17% beyond the DCI-P3 gamut, and an average Delta E of 0.36 tells you everything you need to know about its accuracy.

Where Samsung compromises is battery life. With the screen set at 150cd/m² (plenty for an OLED panel such as this), it lasted for 12hrs 14mins under light use. That's still a terrific result for a Windows laptop, but other Copilot+ PCs – with smaller screens and bigger batteries – last longer. And while this is a sleek laptop, measuring 12.3mm thick if you ignore those rubber feet, you'll notice its 1.6kg bulk. I was

ABOVE The bright and colour-accurate 16in display is larger than other Copilot+ PCs



"Samsung delivers quality in every key area. The Galaxy Book4 Edge is snappier than a starving crocodile"

LEFT Samsung plays it safe with the light blue metal chassis

BELOW The decent keyboard and huge trackpad will help boost productivity

while the layout is spot on. You even get separated cursor keys and a respectably sized number pad. Samsung integrates a fingerprint sensor at the top right, but surprisingly the webcam – an excellent 1080p unit – doesn't support Windows Hello.

The final physical feature to note is a giant touchpad. It's actually wider than the ruler I use to measure touchpads, at 152mm, and a depth of 108mm is similarly vast. I've seen smaller graphics tablets. Needless to say, it will bring a smile to the lips of anyone who uses Windows gestures, and its palm rejection is excellent.

I have criticisms. Samsung could have been bolder with its colour choice, instead playing it safe with a light blue metal chassis. And, as with most other Copilot+ PCs, it's offering limited spec choices: pick 512GB for £1,499 or 1TB for £1,699. Plus, when I'm paying this much, I expect an infrared camera.

This aside, Samsung delivers quality in every key area. The Galaxy Book4 Edge is snappier than Jeremy Paxman, its battery life is strong and the 16in panel nudges its head and shoulders that vital fraction above the opposition. **TIM DANTON**

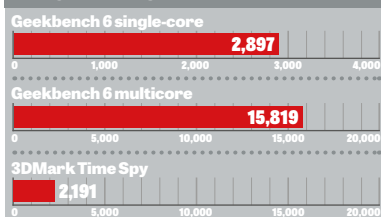
SPECIFICATIONS

12-core Qualcomm Snapdragon X1E-84-100

SoC ● Qualcomm Adreno graphics ● 16GB LPDDR5X RAM ● 16in 120Hz OLED

touchscreen, 2,880 x 1,800 resolution ● 1TB UFS 4 SSD ● Wi-Fi 7 ● Bluetooth 5.3 ● 1080p webcam ● HDMI 2.1 ● 2 x Thunderbolt 4/USB-C 4 ● USB-A 3.2 Gen 2 ● microSD card slot ● 3.5mm combo jack ● 62Wh battery ● Windows 11 Home ● 355 x 250 x 12.3mm (WDH) ● 1.6kg ● 1yr RTB warranty

BENCHMARKS



BATTERY LIFE

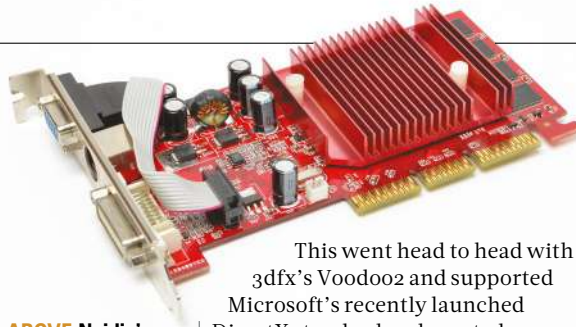




1993

Like all the best ideas, Nvidia's history begins in Denny's. If you've never visited this chain of American diners, think Little Chef but with free coffee refills and lots more ice in your Coke. There's even a plaque to mark the occasion at the Denny's in Silicon Valley where Jensen Huang, Chris Malachowsky and Curtis Priem hatched their plan.

"Denny's has taught me so many lessons," Huang said when the plaque was unveiled in September 2023, having also worked there. "I was a dishwasher, I was a busboy, I waited tables. No-one can carry more coffee cups than I can."



ABOVE Nvidia's AGP cards saw it become a formidable competitor to 3dfx

This went head to head with 3dfx's Voodoo2 and supported Microsoft's recently launched DirectX standard and sported industry-standard connectors.

"Scan launched in 1987," said Marnie Sutton, Scan's director of enterprise GPU, "and just like Nvidia we were evolving as a business during the 90s, experimenting with the emerging possibilities of dedicated graphics cards in our desktop PC range."

One such card was the RIVA TNT, which added support for AGP.

This was also the year when Nvidia went public. According to Forbes, if Curtis Priem, Nvidia's first CTO and one of those Denny's co-founders, had held onto his shares he'd now be worth almost \$100 billion. As it was, he celebrated the company's share price hitting \$100 – over eight times its \$12 launch price – by getting his hair cut and dyed to match the Nvidia logo.

Having taken on 3dfx in the gaming market, 2000 saw Nvidia target professionals with its first Quadro GPU. Through a combination of certification with software developers and hardware designed for CAD, CGI and digital content creation, this was a huge move for the company at the time.

"Quadro graphics cards transformed the workstation

30 YEARS OF NVIDIA GRAPHICS

IN ASSOCIATION WITH SCAN

IN ASSOCIATION WITH SCAN, WE PRESENT A 30-YEAR HISTORY OF NVIDIA'S GROUND-BREAKING RELEASES – A COMPANY THAT STARTING IN GAMING BUT IS NOW A LEADING FORCE IN BOTH WORKSTATIONS AND AI

Huang also considered Denny's the perfect place to start a business, not least as he lived nearby at the time (along with his wife and kids; he was 30 and a director at LSI Logic at the time). Aside from location, it held one crucial advantage. "It had all the coffee you could drink and no-one could chase you out."

1995

After two years, Nvidia released its first product: the NV1. While its single chip included many innovative features, including support for 3D video, it wasn't a hit due to its proprietary features. Success instead came with its second card, two years later, the RIVA 128.

BELOW The "world's first GPU", the GeForce 256, launched in 1999



If you don't remember the advanced graphics port, this is what connected the graphics cards of yore to the motherboard, giving enough bandwidth for 3D graphics.

1999

The GeForce 256, launched in 1999, was the first to sport that famous GeForce brand – and, Nvidia proudly proclaimed, the world's first GPU or graphical processing unit, cleverly echoing the CPU nomenclature. But it wasn't just about branding. The GeForce 256 was the first to implement hardware transform and lighting, offloading complex calculations from the CPU to the GPU.

market," said Sutton. "They offloaded visualisation tasks from what were at the time largely-serial CPUs to hugely-parallel GPUs." He added that it even "drove Scan to launch our 3XS Systems brand".

By 2003, and after launching the GeForce 2 with per-pixel shading and the GeForce 3 with programmable shaders, Nvidia was in the position to buy its former rival 3dfx (now in administration) and gain access to its patents. Less successful: who remembers the launch of the GoForce, a GPU for mobile devices?

2006

If 1999 marked the beginning of the GeForce era, 2006 did the same for

1993

APRIL

Jensen Huang, Chris Malachowsky and Curtis Priem found Nvidia

1995

SEPTEMBER

Nvidia launches its first product, the NV1, which supports 2D and 3D video

1997

APRIL

RIVA 128 establishes Nvidia as a major player in gaming graphics cards

1999

DECEMBER

Nvidia announces the "world's first GPU", namely the GeForce 256

2000

JANUARY

Debut for Nvidia's Quadro brand of GPUs for workstations



ABOVE Scan's fruitful partnership with Nvidia included this striking system

CUDA. This came in the shape of its GeForce 8800 GPU, which introduced both unified shaders and CUDA. Standing for Compute Unified Device Architecture, this software platform meant developers could use the GPU for general-purpose computing tasks – think image processing, cryptography and machine learning – rather than graphics tasks alone.

By now, Nvidia was hitting annual releases that each boasted more transistors and more features – such as support for error-correcting code (ECC), multiple-GPU scaling, remote management. Fantastic for high-performance computing (HPC), including supercomputers, but also workstations.

“Scan was now building thousands of bespoke PCs and professional workstations a month based on these new Nvidia technologies,” said Sutton, “so we created dedicated Pro Gaming, Pro Video and Pro Graphics teams to address these fast-developing markets. Our machines have gone on to win *PC Pro*'s workstation Labs test every year since 2016!”

2012

2012 was another key date in Nvidia's history: it saw the birth of Alexnet. This neural network, devised by Alex Krizhevsky at the University of Toronto, used two

Nvidia cards that employed deep learning techniques to analyse images at a rate never seen before.

As Scan's Marnie Sutton explains, this would have a huge impact. “GPU-accelerated neural networks enabled data scientists to finally develop, train and inference AI models in hours rather than weeks,” he said. “Scan pioneered the concept of the dev box, a workstation with six Nvidia GPUs, bringing datacentre performance to the desktop.” Scan would even add a dedicated AI business unit to serve this burgeoning sector and was recognised with the UK's first Nvidia Elite Partner status.

In 2015, Nvidia made its first foray into the world of automotive computing when it announced its Drive CX and Drive PX automotive platforms. CX was for use in the “cockpit”, while PX processed images to help with self-driving cars. A year later saw the PX2, with Nvidia declaring it the “world's first in-car AI supercomputer”.

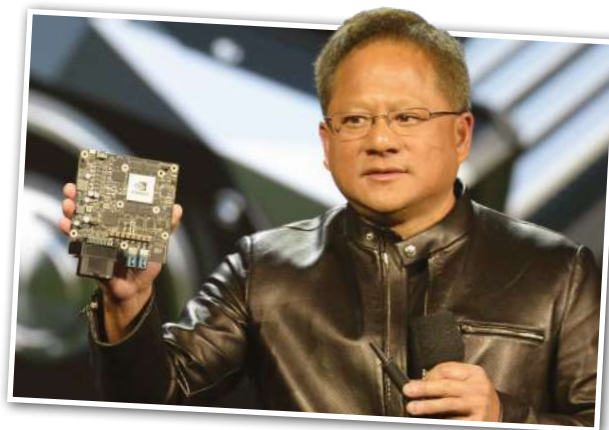
WHY NVIDIA?

In case you've ever wondered, Nvidia stands for “invidia”, the Latin word for “envy”.

2016

By 2016, Nvidia was the market leader for gaming graphics cards – and for creative workstations. There were also early signs of success in the automotive space, with major names such as Volvo partnering up. But, almost unbelievably, the best was yet to come.

While others were slow to spot the AI future, Nvidia continued to innovate in this area, introducing the Hopper-based H100 accelerators in 2022 and the hotly anticipated Blackwell architecture in 2023. But all the way back in 2016, it had donated an Nvidia-powered supercomputer to a little-known startup called OpenAI, and the company was creating innovative large language models on Nvidia



ABOVE Jensen Huang co-founded Nvidia in an American diner

hardware as a result. GPT-2 came in 2019, GPT-3 in 2020.

Scan's Sutton frames the change with one simple phrase: “AI has moved out of the lab and into the real world,” pointing out that the current H100 accelerators are a staggering 46x faster than its original DGX-1 product. That means real-world apps too. “An Nvidia GPU cluster, developed by Scan, KCL and the London AI Centre now serves over 18 million NHS users,” he added. “Meanwhile, our virtual production workstations are transforming the UK film industry.”

At the same time as it invested heavily in AI, Nvidia was continuing its dominance in the desktop graphics scene, bringing real-time ray tracing to games via the RTX series in 2018. But it was in November 2022, when ChatGPT fever broke out, that the world suddenly saw what Nvidia and Scan had known for years: AI was here. It was the future. And it was living on Nvidia hardware.

2024

BELOW Amazingly, there are six Nvidia GPUs in this Scan workstation



On 18 June 2024, Nvidia officially became the world's most valuable company. Due to the latest surge in share prices, its market cap hit a staggering \$3.34 trillion. That's \$3,340,000,000,000.

Obviously, it's not all about the money for Nvidia: it's about the products and what they enable people to do. But it's hard not to be impressed when you see that many zeros after a dollar sign. To put it into real terms, that's enough for 300 billion meals at Denny's. ●

2007

FEBRUARY

Nvidia announces CUDA to the world and with it general purpose GPU computing

2016

AUGUST

Huang hand-delivers the DGX-1 supercomputer to a startup called OpenAI

2018

AUGUST

RTX series launches, bringing real-time ray tracing to desktops

2022

MARCH

Nvidia announces Hopper architecture for data centre AI accelerators

2024

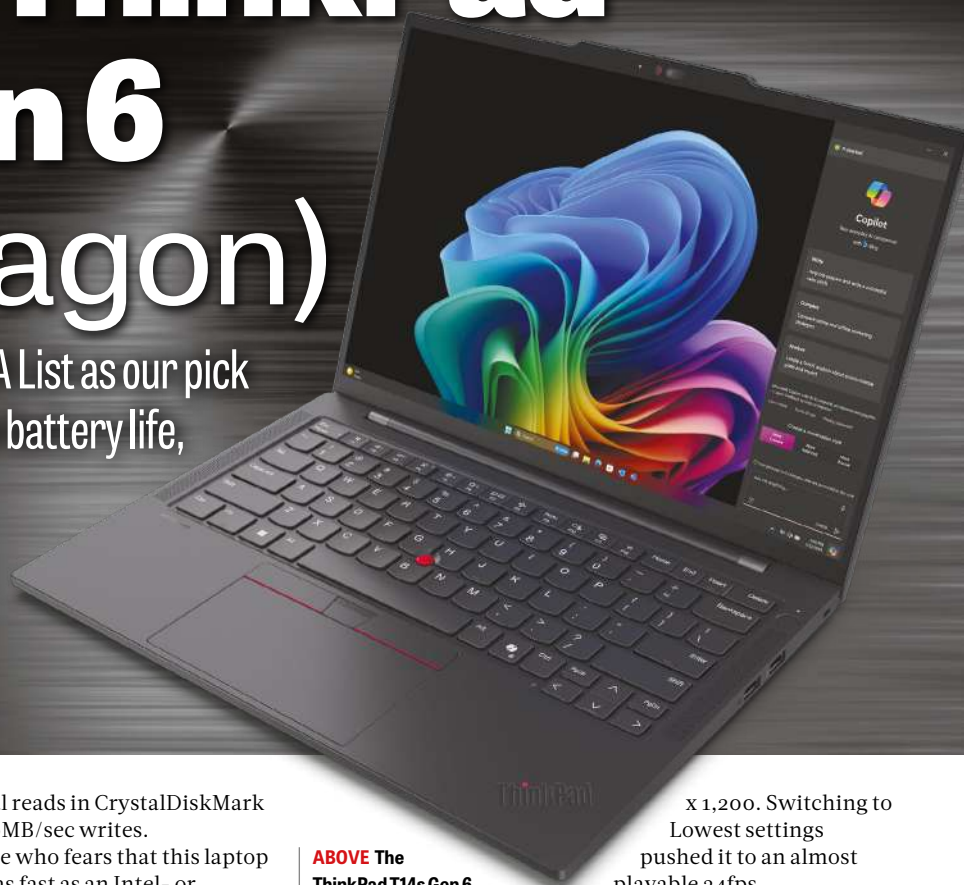
JUNE

Nvidia becomes the world's most valuable company with a \$3.34 trillion valuation



Lenovo ThinkPad T14s Gen 6 (Snapdragon)

Shoots straight to the top of the A List as our pick of the business laptops thanks to battery life, power and price



SCORE ★★★★★

PRICE £1,500 (£1,800 inc VAT)
from [lenovo.com](https://www.lenovo.com)

While we're still waiting for business-focused Copilot+ PCs from Dell, HP and Microsoft, Lenovo has rushed to the corporate buyer's aid by producing a ThinkPad version. Not that it's jumped in too aggressively, as for the moment you can only buy the precise specification on review here.

Fortunately, it's a very tempting mix. For £1,500 exc VAT, you get the 12-core Snapdragon X1E-80-100 chip, which sits second in Qualcomm's pecking order behind the X1E-84-100 in the Samsung Galaxy Book4 Edge (see p53). A little surprisingly, Lenovo has chosen 32GB rather than 16GB to support it, with a 1TB SSD for storage. It's a fast disk, too, hitting 6,191MB/sec

sequential reads in CrystalDiskMark and 4,809MB/sec writes.

Anyone who fears that this laptop won't be as fast as an Intel- or AMD-powered rival should take one look at its scores in Geekbench 6, with the T14s matching the Core Ultra 7 in HP's Elite x360 1040 G11 (see p65) in the single-core test with a 2,447 result and then smashing it with a 14,530 multicore return. Curiously, the HP fought back in Cinebench 2024, scoring 805 versus 746 in the multicore test. It seems that here, the 16 cores and 22 threads of Intel's chip hold the advantage over 12 performance cores in the latest Qualcomm silicon.

The two chips' 3D acceleration abilities are easier to differentiate, with Intel holding a clear advantage. That's reflected in Lenovo's 3DMark Time Spy result of 1,849, which is almost exactly half that of the HP Elite x360 1040's 3,697. But that's unlikely to concern this laptop's buyers.

■ Armed forces

The bigger question for IT managers considering whether to add the T14s to their inventory is compatibility. My own experience – and others who have tested Copilot+ PCs – is that games are the biggest casualty, especially with high detail settings and high resolutions. Here, though, *Shadow of the Tomb Raider* ran successfully on the ThinkPad at Ultra high settings – but only at 19fps and the screen's native resolution of 1,920

x 1,200. Switching to Lowest settings pushed it to an almost playable 34fps.

Few games run natively on Arm, with most using Microsoft's excellent Prism x86 emulation software – and that will hamper frame rates. However, on most apps, most of the time, you won't even notice that they're running under emulation: I estimate my hit rate of success, excluding games, at well over 90%.

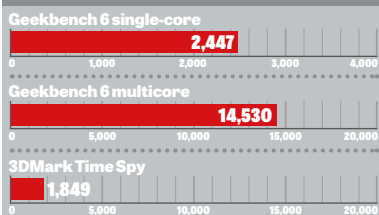
Still, the ideal is for your chosen software to run natively on Arm, and Qualcomm is working hard with software developers to make this happen. Big names include Adobe Photoshop, DaVinci Resolve, Microsoft Office, Netflix, Visual Studio, Docker Desktop, ESET and (a

ABOVE The ThinkPad T14s Gen 6 is the best business laptop you can buy

BELOW The battery will easily get you through a whole day



BENCHMARKS



BATTERY LIFE



little ironically) CrowdStrike. Check the list at tinyurl.com/360qualcomm.

That list is growing, but there's always a danger that software crucial to the running of your business isn't on there, or that you'll need to port across your own software. As ever when shifting to a different platform, proceed with caution.

■ The Copilot+ advantage

Although AMD and Intel are poised to release x86 processors that support Microsoft's Copilot+ PC spec, for the moment Qualcomm has a monopoly. I'm struggling to see why businesses should rush out to buy Copilot+ PCs, but there are arguments. Perhaps the strongest is that it means you can take advantage of generative AI locally, rather than sharing data over the internet, but there's an element of chicken and egg here: until all of a company's users are running machines with AI capabilities, they don't have a strong incentive to develop local AI-based tools for them to run.

So let's put local AI to the side for a moment, and instead consider the advantages of Qualcomm's Arm chips. Quite aside from their phenomenal speed in native apps, and anything that can exploit a dozen high-performance cores, the biggest one is battery life. Lenovo claims "true multiday" battery life from the Snapdragon version of the T14s, and it delivered in our tests: 23hrs 39mins in the PCMark Applications benchmark, which runs a mix of Office and web-based apps.

I achieved that with the screen set at 150cd/m², and while that's plenty for OLED panels I think most people will be happier with this panel pushed close to its 500cd/m² maximum. It should still last for more than 20 hours of typical use, as this is a low-energy display. It's also modest in terms of colour coverage, at 96% of the sRGB gamut and 71% of DCI-P3. It wouldn't be my top choice for binge watching the *Fast and Furious* films, but soundtracks will sound great as Lenovo supplies a fine pair of speakers.

■ A working laptop

Fundamentally, however, this laptop is built for work rather than fun, and that's where it's strongest. The ThinkPad range continues to lead the way for keyboard design, and despite the constraints of such a compact chassis I loved typing on the T14s. The



action is deep, cushioned and quiet, and Lenovo goes to the hassle (and expense) of expanding space below the main keyboard for the cursor keys. There's no function doubling, the Enter key is huge, the Delete key is easy to hit and as ever you get a choice of trackpoint or glass-coated

touchpad. Double-clicking the trackpoint even brings up a menu to quickly control the microphone and speaker settings.

There's an eminently sensible collection of ports here, too.

Two USB-C 4 ports sit to the left, one of which you'll need when charging – it goes

from zero to 52% in 30 minutes – and you'll find a tiny LED to indicate amber if it's not quite full. Lenovo also squeezes in an HDMI 2.1 port and 3.5mm combo jack here. Head to the right and you'll find two USB-A 3.2 Gen 1 ports plus a nano lock. Sadly that means no room for an Ethernet port, but Wi-Fi 7 and Bluetooth 5.3 are both present.

Lenovo's practical design extends to a tiny lip at the top of the screen, which houses a decent (though not

fantastic) 1080p webcam that also makes it easier to lift the lid when closed. Naturally, the camera supports Windows Hello logins, and there's a fingerprint sensor built into the power button, too.

■ Think about buying

My final words of praise are around Lenovo's approach to repair, with the company earning rare acclaim from iFixit for its efforts. It uses post-consumer content where it can, including 90% recycled plastic and up to 90% recycled magnesium, helping it earn TCO 9, Energy Star 9 and EPEAT Gold certifications.

It's easy to repair, too. With five captive crosshead screws securing the base, and easy unclipping, I was inside this chassis within a minute. There are a handful of QR codes on hand to help identify components, but as with all Snapdragon chips the memory is integrated so your most likely future upgrade is to replace the M.2 2280 SSD.

Lenovo only includes a one-year warranty, but promises that this laptop meets the demanding MIL-STD 810H tests

and meets or exceeds "12 standards, 26 procedures and 200+ quality checks" that show it will run in extreme conditions. And, for more down-to-earth problems, the keyboard is spill-resistant.

All of which is great, but what I love about this laptop is that it combines power and terrific battery life in a 1.2kg chassis

that's so compact it can fit in my tiniest rucksack. I can't get so enthused by the display, but a brilliant keyboard and thoughtful design elements make it a superb choice

whether you want to dip your company's toes into the Copilot+ PC water or you're looking for a highly portable professional laptop for yourself. **TIM DANTON**

ABOVE The ThinkPad range leads the way for keyboard design

"This laptop combines power and terrific battery life in a 1.2kg chassis that can fit in my tiniest rucksack"

BELOW Connections include HDMI, two USB-C 4 and two USB-A 3.2 ports

SPECIFICATIONS

12-core Qualcomm Snapdragon XIE-78-100 SoC • Qualcomm Adreno graphics • 32GB LPDDR5X-8448 RAM • 14in 60Hz IPS non-touch display, 1,920 x 1,200 resolution • 1TB M.2 PCI-E Gen4 SSD • Wi-Fi 7 • Bluetooth 5.3 • 1080p IR webcam • HDMI 2.1 • 2 x Thunderbolt 4/USB-C 4 • 2 x USB-A 3.2 Gen 1 • 3.5mm combo jack • 58Wh battery • Windows 11 Pro • 313 x 219 x 16.9mm (WDH) • 1.2kg • 1yr on-site Premier warranty





Framework Laptop 13 (DIY Edition, AMD)

An easy laptop both to build and repair, with the bonus of a speedy AMD chip and your choice of ports

SCORE ★★★★★

PRICE As reviewed, £1,078 (£1,294 inc VAT) from frame.work

Framework takes a different approach from most laptop makers, with an emphasis on repairability. It even adopts a modular approach to ports, so you can swap a USB-A port for an HDMI connector on the fly.

As my guide to building a Framework opposite shows, however, this isn't a DIY system in the same way that you might build a desktop PC. Framework supplies the chassis with the motherboard and display built in, so all you're doing is adding the SSD, memory, keyboard, ports and bezel of your choosing. Install Windows or Linux, and the relevant drivers, and you're done.

Or you can buy a laptop preassembled and pre-loaded with Windows. There isn't a huge difference in the price, but I would expect most *PC Pro* readers to choose the DIY approach.

■ Chip choice

Framework sent me its top AMD version of the Laptop 13, which features a Ryzen 7840U, but it offers an à la carte menu of chips. For instance, you can choose from Intel's Core Ultra range or save money by opting for a 13th generation Core CPU.

There's also a choice of display. My review unit included the basic 60Hz panel with a 2,256 x 1,504 resolution,

but for an extra £130 Framework offers a 2,880 x 1,920 screen that goes up to 120Hz. This also comes with a more advanced webcam; the one bundled with my laptop produced solid 1080p results – fine for business calls – but forget effects such as background blur. There's no IR sensor for Windows Hello logins, either, but Framework includes privacy switches for the webcam and the microphones.

One of the many great things about Framework's approach is that if something goes wrong you

can fix it or replace it, and that includes the display and the motherboard. With a strong community and detailed resources from Framework, you may prefer to dig out your screwdrivers rather than taking the laptop to a repairer.

■ Full metal jacket

Despite its utilitarian nature, the Framework 13 is a compact and slim laptop. It's well made, too, with no obvious weak points. The only area where it arguably falls behind rivals is for style, with a simple, utilitarian

ABOVE It's not the most stylish laptop, but it is one of the most sustainable

"One of the many great things about Framework's approach is that if something goes wrong you can fix it or replace it"

LEFT The design may be utilitarian, but the Framework Laptop 13 is well built

BELOW You can pick from (and then fit) a multitude of keyboard languages

look. I like the simplicity, but others may prefer a more stylish design. You can choose coloured bezels, keyboard covers and expansion ports if you want to live things up.

There's nothing fancy about the keyboard, either, but the action is deep and solid, with only a trace of cushioning. Ham-fisted typists will find it clacks loudly, but those with a gentler typing style will be rewarded with quiet strokes. The UK layout includes a double-height Enter key, with the only compromise being

half-height up/down cursor keys and some function doubling.

A nicely proportioned and slick touchpad sits beneath, with a fingerprint sensor above. This worked perfectly throughout.

■ Plain Jane screen

It's a shame Framework sent me the model with the cheaper screen, as this is one area where the Laptop 13 falls behind rivals. There's nothing wrong with its resolution or refresh rate, but colour coverage could be better: it's tied to the sRGB space, covering 96%

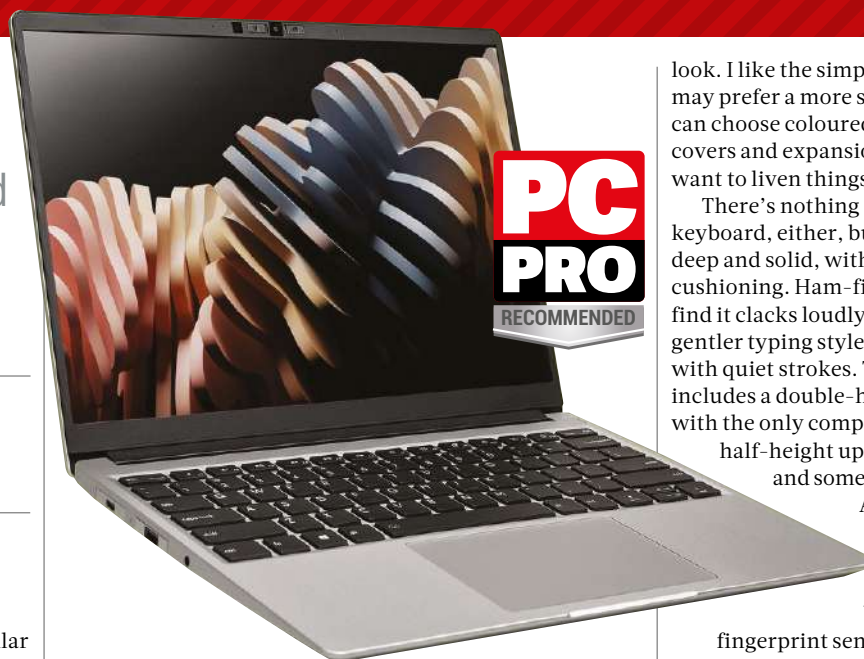
out of a 100% volume, and that means DCI-P3 coverage is stuck at 71%. Colours lack punch as a result, but accuracy is respectable (0.63 Delta E average) and it goes up to 467cd/m². The panel's native colour

temperature of almost 7000K means whites look a fraction "cold".

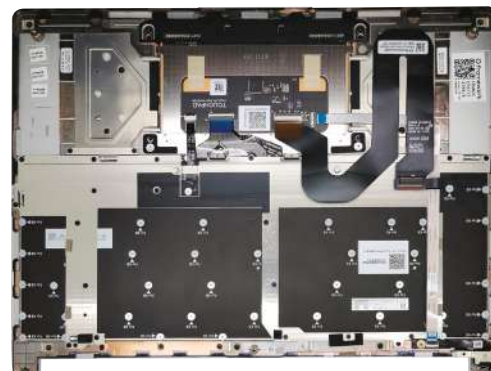
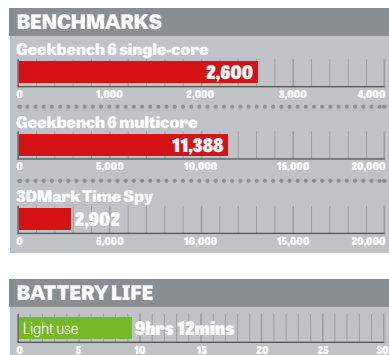
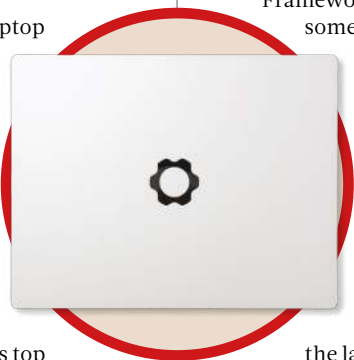
You can always hook it up to an external screen. The only connector that Framework stipulates is USB-C, as this is used for charging (and data/monitor duties), which leaves three for you to play with – it's possible to swap them out whenever you like – so if you need DisplayPort or HDMI then add them to your order. Or take your pick from USB-A, Ethernet, microSD, or even storage expansion cards.

■ Need for speed

With a Ryzen 7840U inside my test system, I expected fast speeds. And



PC PRO
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How to build your laptop

Framework sent me the DIY Edition of the Laptop 13, but anyone who regularly reads *PC Pro* will have no trouble putting it together. Framework even supplies its own versatile Framework Screwdriver – a combo crosshead/Torx T5 screwdriver and spludger – in the box. Don't throw it away, as you'll need it when the time comes to upgrade or remove items.



STEP 1 Unpack everything!

You get a lot of boxes in the box (two boxes in my case). The "barebones" chassis, a bezel cover, keyboard unit, the tool and your choice of expansion cards. You must select four cards, one of which will need to be USB-C to charge the device. Optionally, you can buy DDR5-5600 SODIMMs from Framework or use your own; likewise the M.2 2280 NVMe SSD.

STEP 2 Clip on the bezel

This is so easy I'm not even going to dignify it with a picture or more than a sentence.



STEP 3 Add the memory and storage

For safety, ground yourself before you start handling the memory and storage. Let's not take risks. Once that's done, you slide the memory into place, click it down (trying to avoid the NAND chips), and that's it. It's best to use two SODIMMs as that increases your bandwidth. Next, unscrew the holding screw for the SSD, then slide the drive into place and lower it down. Then screw the holding screw back in.

STEP 4 Attach the keyboard cover

Your next step is to add the keyboard. First, it must be connected to the mainboard via a ribbon cable. Handily, Framework includes a loop to make it easy to remove too. Once connected, the



keyboard cover snaps on exactly as you'd expect. Don't worry if it appears loose in places as it will tighten once you flip the laptop over and screw in the five Torx screws.

STEP 5 Add your choice of expansion cards

These slot in easily. It's not quite as easy to replace these ports, though, with a catch keeping them in place: press this down and then give a vigorous push to unseat the connector (the spludger tool can help).



STEP 6 Install your OS of choice

You can either install a Linux distribution (Framework designed the Laptop 13 to work well with Linux) or Windows. Either way, upgrade the firmware, and if you choose Windows then make sure that you also download the driver bundle (both the firmware and drivers are available from tinyurl.com/360driverbundle). Once installed, that's it: you're the proud owner of a fully fledged laptop.

that's exactly what I saw. AMD's Zen 4 architecture remains strong, with a 2,600 result in Geekbench 6's single-core test and a solid 11,388 in the multicore test; having eight cores means it now falls behind the fastest chips from Intel and Qualcomm. It was a match for the Copilot+ PCs in Cinebench 2024, though, with 790 in the multicore section and 104 in the single-core test.

AMD's Radeon 780M graphics are roughly on a par with Intel's Arc chips, scoring 2,902 in 3DMark Time Spy. At the panel's native resolution, it coped well in both *Shadow of the Tomb Raider* and *Dirt 5* so long as I kept to the lowest detail settings, averaging 39fps and 44fps respectively. Switching to High proved too big a challenge, with frame rates topping to 24fps and 28fps.

Unlike the Copilot+ PCs I've tested this month with Qualcomm Snapdragon chips inside, the Framework Laptop 13's fan lets you know when the CPU is being pushed. It doesn't help that Framework uses a single

fan for cooling, but those who like a quiet existence should either choose a different laptop or stick to undemanding tasks.

Battery life is respectable, lasting 9hrs 12mins in the light-use test and a superb 16hrs 26mins when left idling. But don't expect speedy recharging from the modestly sized 60W adapter, going from zero to 45% in half an hour.

Final thoughts

Buying a Framework laptop isn't the best choice for those who seek instant gratification. It will take at least five business days to ship your custom order, and if you want the latest parts – such as the new screen and webcam combo – then you'll have to wait for the next batch to

“While rivals are undoubtedly sleeker and arguably sexier, I love Framework's approach to modularity and repairability”

arrive, similarly to a Kickstarter project. Even so, the wait should be a few weeks at most.

Instead, this is a long-term purchase. One that will last for

years – a decade even – and so it makes sense not to rush in. While rivals are undoubtedly sleeker and sexier, I love Framework's approach to modularity and repairability.

You're paying a slight premium for this, but you're also supporting a company that lives and breathes sustainability, which you simply won't find if buying from one of the big brands. **TIM DANTON**

SPECIFICATIONS

8-core/16-thread AMD Ryzen 77840U processor • AMD Radeon 780M graphics • 16GB DDR5-5600 RAM • 13.5in 60Hz IPS non-touch panel, 2,256 x 1,504 resolution • 512GB M.2 PCI-E Gen4 SSD • Wi-Fi 6E • Bluetooth 5.1 • 1080p IR webcam • 4 x expansion ports • 61Wh battery • no OS • 296 x 229 x 15.7mm (WDH) • 1.3kg • 2yr limited warranty

BELOW You can take your pick of connectors for the three spare ports





Palicomp AMD Destiny

It lacks frills, but this RTX Super 4070-toting PC delivers 4K gaming for a competitive price

SCORE ★★★★★

PRICE £1,042 (£1,250 inc VAT) from palicomp.co.uk/destiny-mag1

One of the most aggravating things about buying technology is that you can always go one further. Spend a little more, get a little more. And that's exactly the case if you increase your budget from £1,000 to £1,250, with the Palicomp AMD Destiny offering a significant speed hike over the CyberPowerPC opposite.

The vast majority of this is due to the presence of an RTX 4070 Super card rather than an RTX 4060. At retail, the 4070 Super costs around £600 compared to £300 for its lesser sibling, and it's roughly twice as fast, too. 3DMark Time Spy is a great measure of this, with the Destiny scoring 18,932 versus 10,518 for the Infinity X145 Elite.

In practice, I can simplify the differences between the two machines in one sentence: the Destiny is a solid option for 4K gaming where the Infinity is not. That's shown by a trio of results at 4K and High settings in *Cyberpunk 2077*, *Shadow of the Tomb Raider* and *Dirt 5*, where Palicomp's PC returned averages of 79fps, 114fps and 119fps compared to 39fps, 57fps and 54fps. It doesn't take a mathematician to spot that the Destiny's scores are almost exactly twice as fast.

Palicomp has given the RTX 4070 Super a helping hand by using one of the fastest gaming processors on the planet, namely the AMD Ryzen 7 7800X3D. The chip's X3D suffix indicates the extra Level 3



PC PRO
RECOMMENDED

3.5in hard disk caddy. There's also a rat's nest of cables, but at least that allows Palicomp to keep the visible side of the Destiny relatively empty. This is mainly for aesthetic reasons, as on-board upgrades are minimal: only one PCI-E x1 slot is accessible.

You can at least add to the memory, with two unimpeded DIMM sockets lying empty despite the size of the air cooler. DeepCool isn't a name I'm familiar with, and while it does its job well – together with the total of six RGB fans on the front, top and back of this PC – it contributes to a continual hum from the Destiny. It's by no means annoying (more the kind of hum that you only notice when the PC is switched off) but it's reflected in the idle power draw

of 84W compared to 52W for the CyberPowerPC Infinity.

The Kolink Observatory HF Mesh chassis is basic, but does allow all those RGB lights to shine through and has a handy hinged door to make accessing the innards simple. Palicomp also saves money by choosing a CIT 80 Plus Bronze-rated power supply, rather than a bigger name with better efficiency ratings, but at 700W it won't hold you back.

One of Palicomp's perks is that you can pick from a variety of components at time of purchase, from CPU to GPU to PSU, and you can also upgrade the warranty. I would consider doing this, as it's one area where this PC

falls behind CyberPowerPC – only the first year includes parts, and you have to pay for courier costs. £108 buys three years of C&R cover. You may also be tempted to pay for faster delivery than the standard ten working days, with £75 accelerating that to the next business day.

Overall, the Destiny isn't as refined a package as the CyberPowerPC opposite, but there's no arguing with its powerful components, which are all geared towards one thing: making games run fast. **TIM DANTON**

SPECIFICATIONS

8-core/16-thread AMD Ryzen 7 7800X3D processor • Asus TUF Gaming A620M-Plus WiFi motherboard • 32GB DDR5-5600 Adata Lancer Blade RAM • 12GB Palit GeForce RTX 4070 Super graphics • DeepCool AG400 air cooler • 1TB Adata S70 Blade PCI-E Gen 4 SSD • Kolink Observatory HF Mesh chassis • 700W CIT PSU • Windows 11 Home • 200 x 390 x 449mm (WDH) • 3yr RTB warranty (1yr parts) • power, 84W idle, 375W peak

cache (made possible by a 3D-stacked chipset) that AMD adds over the standard 7800X, which gives an instant boost in most games.

The downside of AMD's X3D range of chips is that they don't have an unlocked multiplier and can't boost to as high frequencies as their "X" counterparts, so if gaming isn't your main use then you're better off with the 7800X (or even the Ryzen 7 7700X, which is roughly 7% faster in multicore tasks). However, in its own right the 7800X3D is a brilliant day-to-day processor, pushing the Destiny to 2,705 and 14,806 in Geekbench 6, 110 and 1,028 in Cinebench 2024, and 1,765 and 17,017 in Cinebench R23 (single-core results first, multicore second).

An overall score of 8,772 in PCMark is also one of the highest I've seen, and here I must give due praise to the supporting cast of 32GB DDR5 RAM and a 1TB Adata S70 Blade SSD. The latter is particularly fast, with an astounding 7,476MB/sec sequential reads transfer rate in CrystalDiskMark and a none-too-shoddy 5,461MB/sec result in the writing test.

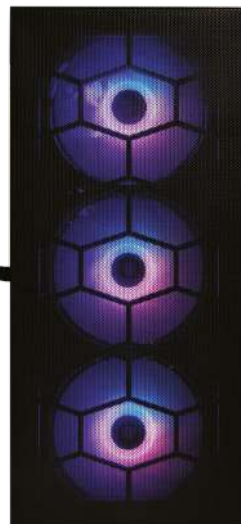
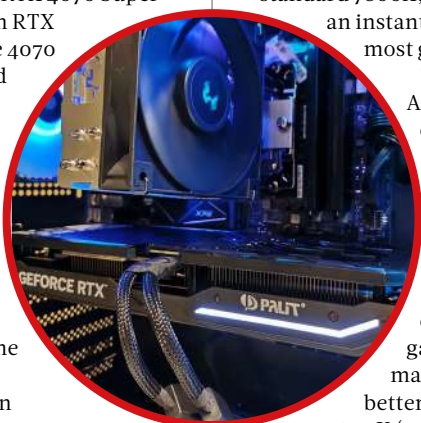
If you're thinking 1TB is too small for your needs, there's one empty M.2 slot on the AMD TUF Gaming motherboard, while removing the right side of the chassis reveals two mounting spaces for 2.5in SSDs and one

ABOVE The Kolink chassis has a hinged door so accessing the innards is simple

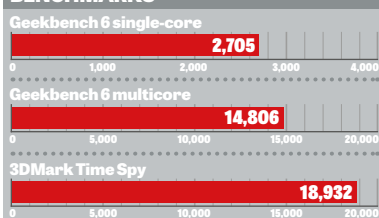
LEFT An RTX 4070 Super graphics card takes centre stage

"One of Palicomp's perks is that you can pick from a variety of components at time of purchase, from CPU to GPU to PSU"

BELOW The Destiny is designed with 4K gaming in mind



BENCHMARKS



CyberPowerPC Infinity X145 Elite

A well-balanced system for gamers with a grand to spend, and there's room to grow in the future

SCORE ★★★★★

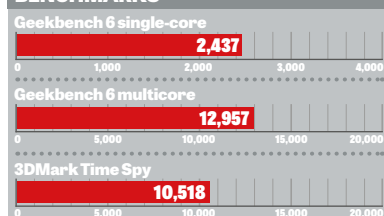
PRICE £833 (£999 inc VAT)
from tinyurl.com/360cyber

Timing is everything when buying a gaming PC. You want to squeeze every last morsel out of your budget at the moment of purchase, and right now, CyberPowerPC is backing Intel's mid-range Core i5-14400F processor due to its bang-per-penny: you have ten cores and 16 threads when you need them, but a single core can push up to 4.7GHz using Intel's Max Turbo mode. A generous 32GB of DDR5 RAM means that memory will never be a bottleneck.

The Intel chip's main partner in crime is Nvidia's GeForce RTX 4060 graphics, which inevitably don't have the numbers of the RTX 4070 Super in the Palicomp system opposite – their respective scores of 10,518 and 18,932 in 3DMark Time Spy underline the difference in power – but are enough for fluid 1440p gaming.

You may have to compromise on detail settings if you want to hit 100fps, however. At High detail, *Cyberpunk 2077* averaged 80fps, *Dirt 5* hit 97fps, *Shadow of the Tomb Raider* broke through to 103fps but *Metro Exodus Enhanced* managed only 63fps. Moving to Ultra detail dropped those respective results to 53fps, 77fps, 93fps and 59fps. 4K gaming is too ambitious with this set of games, only breaking the 60fps barrier when I activated DLSS in *Shadow of the Tomb Raider*.

BENCHMARKS



For this PC's foundation, CyberPowerPC chooses the MSI Pro Z790-S WiFi, which is part of MSI's professional series. That means no RGB, with chunky black heatsinks the order of the day. This includes a shield to cover the main M.2 drive, a fast 1TB WD Black SN770, with a second M.2 slot available.

You also get Wi-Fi 6E and Bluetooth 5.3 built in, while the rear of the board offers a 2.5GbE LAN port, one USB-C 3.2 Gen 2x2 port (20Gbits/sec) and six USB-A ports.

There's no support for case-mounted USB-C ports, which may be one reason why CyberPowerPC opted for the Eluna 243 chassis. This includes three USB-A ports conveniently located along the front, next to the power button. The button kept sticking in my tests, but when I brought this to the attention of CyberPowerPC it assured me the problem had now been fixed.

That's a relief, because this is a nice-looking chassis, with a subtle white grille effect on the front that allows the trio of RGB fans to shine through in a subtle haze rather than a blast of colour. Naturally, there's a tempered glass panel

on the side to give an unimpeded view, which will be dominated by the 120mm RGB fan atop the Cooler Master air cooler. Having read Lee Grant's views on liquid coolers this month (see p113), I'm more than happy with that choice.

This provides ample cooling to Intel's Core i5 processor, which performed to its full in every test: along with the Geekbench 6 scores below, it scored 13,829 in Cinebench R23 multicore, while switching to the newer Cinebench 2024 (the scores aren't comparable with R23) it hit 837 in the multicore section, 106 for a single CPU core and 9,747 in the GPU-specific test. That compares to 1,028, 110 and 18,785 for the more expensive Palicomp PC opposite.

CyberPowerPC's choice wins for efficiency, however, consuming 52W at idle and peaking at 309W across our tests. It was a quiet guest in my lab, too, only going above a low hum when playing games. A high-quality 650W, 80 Plus Cooler Master power supply means you have plenty of "power budget" if you decide to upgrade any components, while there is room for internal expansion thanks to three

empty PCI-E slots.

Technically two DIMM sockets are also free, but you'll need to switch coolers as its fan overlaps the first slot. Remove the chassis' left-hand panel and you'll also find space

for three more drives, with one 2.5in drive mounting plate and caddies for two 3.5in disks.

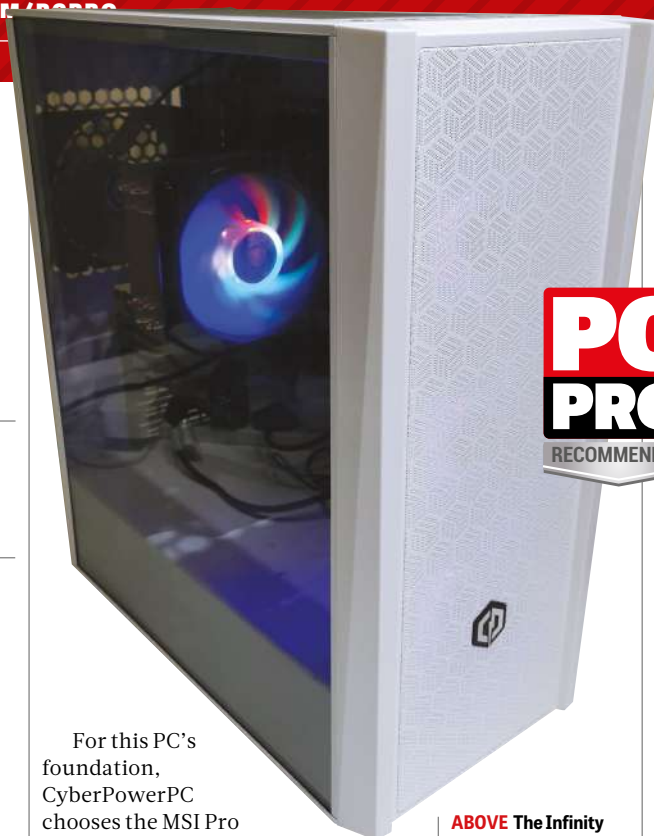
I also appreciate the five-year warranty, with the first two years covering parts, labour and courier costs; the final three years are labour-only, and you'll need to stump up for shipping to CyberPowerPC UK's Gateshead base. In fact, I liked everything about this PC apart from the niggles I faced with that power button. **TIM DANTON**

ABOVE The Infinity X145 Elite is a fine PC for under a grand

"You have ten cores and 16 threads when you need them, but a single core can push up to 4.7GHz when required"

LEFT A 120mm RGB fan sits on top of the air cooler

BELOW The Eluna 243 chassis provides lots of room for expansion



SPECIFICATIONS

10-core (6 P-cores, 4 E-cores) Intel Core i5-14400F processor
● MSI Pro Z790-S WiFi motherboard ● 32GB DDR5-5200 Corsair Vengeance RAM ● 8GB MSI GeForce RTX 4060 graphics ● Cooler Master Hyper 212 Spectrum V2 air cooler ● 1TB WD Black SN770 PCI-E Gen 4 SSD ● CyberPowerPC Eluna 243 White chassis ● 650W Cooler Master MPE-6501 PSU ● Windows 11 Home ● 216 x 455 x 490mm (WDH) ● 2yr parts and labour C&R warranty (5yr labour-only RTB) ● power: 52W idle, 309W peak



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Acer Aspire S32 All-in-One PC

If you love expansive screens then this 31.5in all-in-one is a solid buy for the money – and the touchpad is fantastic

SCORE ★★★★★

PRICE £1,249 (£1,499 inc VAT)
from currys.co.uk

Most all-in-one PCs include 24in or 27in panels, but Acer is thinking big with the Aspire S32. This includes a 31.5in display, and the company doesn't stop there: via a set of pogo pins at the rear, it bundles a veritable feast of add-ons.

The first is a plain 1080p webcam, which is more than good enough to use for video calls. Second comes a 720p camera with a ring light: tap the top and it cycles from off to full-blast white. And the third is a strip light that switches between white, yellow or a mix of the two. All of the add-ons work via USB-C, too, so you can mix and match.

Acer also bundles an enormous detachable touchpad. This can even act as a graphics tablet, so those with artistic leanings can use the bundled stylus – which clips via magnets to the side of the touchpad when not in use – to sketch. And if you use the Aspire S32 as a surrogate TV in a den or student digs then you can detach the touchpad and use it from sofa distances. I spent a very enjoyable ten minutes watching Greg Davies' *The Cleaner* – the pad works like a gigantic remote, with controls for volume and brightness – from this distance until I remembered I had to actually write this review.

Audio could be improved: soundtracks lack the gusto their creators intended, and even though I pushed the volume to the maximum (with minor distortion), I would have liked more. However, the image quality is more than good enough for TV viewing and work.

It has three minor weaknesses as a PC monitor. Some might want more



detail than 2,560 x 1,440 when stretched across 31.5 inches, although in practice I found its 93ppi sharpness fine even when sitting up close. Second, colour accuracy only just the right side of acceptable, with an average of 2.62. And third, its native colour temperature is a yellow-tinged 5653K, so those who like crisp whites will be disappointed.

The panel has one big strength that arguably outweighs its flaws, which is colour coverage. With 90% of the DCI-P3 gamut in view, even Hollywood films look good on this all-in-one, and a peak brightness of 347cd/m² is plenty, too.

You won't find the latest silicon inside, but I have no argument with Intel's Core i7-1360P processor. It remains a speedy performer in everyday use, even if it doesn't wow in benchmarks. Here, it was hampered by having 8GB of RAM rather than the 16GB you'll find in retail units; this will also significantly boost its graphics performance. I would expect

ABOVE A giant detachable touchpad sits at the base, along with a stylus

"If you use the S32 as a surrogate TV in a den or student digs then you can detach the touchpad and use it from sofa distances"

is perhaps one reason why the height isn't adjustable; there simply isn't room to fit in a sliding mechanism. That means you're stuck with the bottom of the panel sitting around 150mm above the desk and the top 550mm above desk height, which means it will tower over most people.

The other downside of cramming the electronics into the narrow stand is that things get hot. I could hear the low hum of the fan throughout my time testing this PC, growing to a loud whirr in more intense benchmarks. I had also hoped for more than one USB-C port, but with a total of four USB-A ports, an SD card slot, gigabit Ethernet and two HDMI ports (one output, one input) there's no shortage of connectivity overall.

Wi-Fi 6E is another welcome inclusion.

One USB-A port is needed for the wireless keyboard and mouse connector, which are of precisely the quality you would expect for bundled

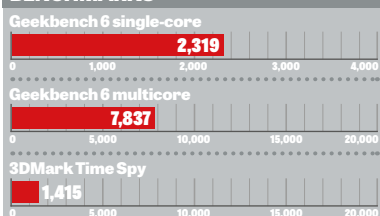
extras. Acer is more generous with its storage, throwing in a 1TB SSD.

Despite my criticisms, I grew fond of this machine. Even when hampered by that 8GB of RAM it sped through everyday tasks, while all the extras lift it above the normal all-in-one. Then again, so does the price: at £1,499 it's too expensive. If that price drops – and I suspect it will – then I might just be tempted to nab one for my future den. **TIM DANTON**

SPECIFICATIONS

12-core (4 P-cores, 8 E-cores) Intel Core i7-1360P processor • Intel UHD graphics • 16GB DDR4-3200 RAM • 31.5in 60Hz IPS non-touch panel, 2,560 x 1,440 resolution • 1TB M.2 PCI-E Gen4 SSD • Wi-Fi 6E • Bluetooth 5.3 • 2 x detachable webcams (1080p, 720p) • detachable light bar • gigabit Ethernet • 2 x HDMI (one input, one output) • USB-C 3.2 Gen 2 • 2 x USB-A 3.2 Gen 2 • 2 x USB-A 3.2 Gen 1 • 3.5mm combo jack • SD card reader • 2 x 2W speakers • Acer wireless keyboard and mouse • Windows 11 Home • 713 x 178 x 553mm (WDH) • 11kg • 1yr RTB warranty

BENCHMARKS



LEFT The huge 31.5in display provides superb colour coverage



Lenovo Yoga 9i 2-in-1 Gen 9

A fun-focused 14in 2-in-1 that's bundled with a feast of extras, including a stylus, but the price is stiff

SCORE ★★★★★

PRICE £1,417 (£1,700 inc VAT)
from lenovo.com

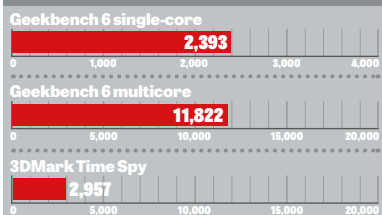
While HP's Elite x360 2-in-1 opposite would wear a bowler hat if it could, the Yoga 9i is a free spirit. It wants you to make art not presentations, to view films not spreadsheets, to sit in cafés not end-of-quarter sales meetings. That's not to say it can't look serious – if anything, the slim, dark blue metal chassis could be a funkier colour – but it essentially screams entertainment.

Let's start with the 14in OLED panel. While it peaked at a modest 402cd/m² in our SDR tests, its VESA TrueBlack 500 certification shows in punchy colours when watching films or playing games. It covers 119% of the DCI-P3 gamut and you can trust its colours, too, with an average Delta E of 0.45. The native colour temperature is a fraction warm, so whites aren't as blazing as I like when typing in Word, but a density of 242ppi thanks to its 2,880 x 1,800 resolution makes the edges of text look razor sharp.

Lenovo includes its Slim Pen stylus, which magnetically attaches to the top of the lid. I love the firmness of the connection, but it doesn't charge at the same time; there's a USB-C slot at the top of the pen. As ever when using a plastic tip on a glass surface you can't expect a paper-like experience,



BENCHMARKS



BATTERY LIFE



but digital artists will appreciate the minimal 18ms lag, and the Smart Notes app is great for scribbles and sketches. At 1.3kg this isn't an iPad rival, but I was happy holding it in the crook of my arm while doodling.

The keyboard is no ThinkPad in terms of "feel", but there's a generous 1.5mm of travel and the keys are large and easy to hit. Lenovo adds a bunch of shortcut keys on the right-hand side: eye-care mode, mute, a shortcut to its useful Vantage app for controlling settings, and a performance mode switcher.

During benchmarking I opted for Lenovo's high-performance mode, but don't get too excited. Intel's Core Ultra 7 155H is a fine processor, but the Geekbench 6 scores printed below won't concern AMD or Qualcomm, while its PCMark 10 score of 6,392 is strong but not incredible. Likewise a multicore result of 816 in Cinebench 2024.

Where Intel's chip continues to beat Qualcomm is gaming, and there is potential here: 41fps in *Dirt 5* at 1200p is a respectable return, as is 30fps at the screen's native resolution, but you'll need to find less demanding titles to benefit from the panel's 120Hz refresh rate. I thoroughly enjoyed *Dirt 5*'s pumping soundtrack through the Yoga's speakers, though, with far more bass than I'm used to from laptops. That's thanks to a pair of 2W woofers in the base.

Unlike the ThinkPad T14s (see p56), the Yoga 9i isn't designed for easy maintenance. The difficulty isn't so much in getting inside the chassis – four Torx T5 screws offer little resistance – as what you can do once you're

ABOVE This is by no means a bad laptop, but others offer better value

"Despite all the quality on show, the price feels like it should be closer to £1,300 to make it competitive"

LEFT The Yoga 9i is encased in a slim, dark blue metal chassis

BELOW Colours pop when watching films or playing games



there. It's good to see QR codes to help identify components, but I would only feel confident replacing the M.2 SSD – a scorching 1TB unit that returned 6,197MB/sec sequential reads – and the 75Wh battery.

Two months ago, I would have been full of praise about this laptop's battery life: 12hrs 40mins under light use is a fine result. Or it was, until Snapdragon-based chips

almost doubled my expectations. Still, that's enough to mean you don't need to sling the 65W charger into your bag on the daily commute, and it recharges speedily: 41% in half an hour, 75% after an hour.

Lenovo is throwing in a couple of sweeteners. Use the part code 83AC000FUK and you'll receive a swanky cover – complete with a loop for the stylus – and a three-in-one USB-C hub that adds USB-A, VGA and HDMI. These complement the three USB-C ports and one USB-A port tucked into the laptop's narrow

base (there's a 3.5mm headphone jack, too). It's a shame the hub doesn't include an RJ45 port, and while I'm wishing it would also have been nice to see Wi-Fi 7 rather than Wi-Fi 6E.

You can configure the Yoga 9i 2-in-1 Gen 9 on Lenovo's website, with options such as 32GB of RAM, a higher-res screen and a grey finish rather than blue. But this pre-configured system is better value, especially as it was on sale for £1,500, a £200 discount, at the time of going to press. Still, I'm not convinced that's bargain enough. Despite all the quality on show, the price feels like it should be closer to £1,300 to compete with the deluge of laptops currently appearing on shelves. **TIM DANTON**

SPECIFICATIONS

16-core (6 P-cores, 8 E-cores, 2 LPE-cores) Intel Core Ultra 7 155H processor • Intel integrated Arc graphics • 16GB LPDDR5X-7467 RAM • 14in 120Hz OLED touchscreen, 2,880 x 1,800 resolution • 1TB M.2 PCI-E Gen4 SSD • Wi-Fi 6E • Bluetooth 5.3 • 1080p IR webcam • 2 x Thunderbolt 4/USB-C 4 • 2 x USB-A 3.2 Gen 2 • 3.5mm combo jack • 75Wh battery • Lenovo Slim Pen • USB-C 3-in-1 hub • 14in sleeve • Windows 11 Home • 316 x 220 x 15.9mm (WDH) • 1.3kg • 1yr C&R warranty • part code, 83AC000FUK

HP Elite x360 1040 2-in-1 G11

A solid 2-in-1 choice for businesses, especially those already committed to HP hardware

SCORE ★★★★★

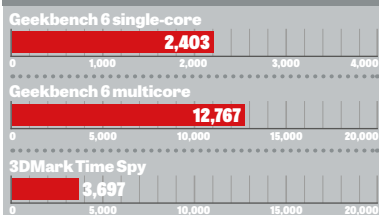
PRICE As reviewed, £1,400 (£1,680 inc VAT) from [hp.com](https://www.hp.com)

While Copilot+ PCs with Qualcomm Arm chips are gaining plenty of attention, there are compelling reasons to stick with the traditional approach. We await the killer app for AI on laptops, and Intel's Core Ultra chips remain better all-rounders: the x86 architecture is still king on Windows and Intel's Arc graphics are far more accomplished than anything Qualcomm can offer.

Despite my words of praise for Lenovo's ThinkPad T14s (see p56), there are good reasons for business buyers to remain cautious and stick with a traditional approach. Chief among them is compatibility, as the last thing a business wants to do is a mass roll-out of laptops that are incompatible with key software or the office printer.

For the 11th generation of its x360 2-in-1, HP isn't ripping up any trees. But what it is doing is packing this laptop with power, with my test system including the excellent Core Ultra 7 155H and 32GB of RAM. Intel may point to the battery life of this machine as an example of its efficiency, too. In PCMark's light-use benchmark, which uses a mix of web browsing and office apps, it lasted 17hrs 42mins despite a relatively modest 68Wh battery. Playing video, it almost reached 20 hours.

BENCHMARKS



BATTERY LIFE



The low-energy screen helps, with the 1,920 x 1,200 IPS panel peaking at 60Hz rather than 120Hz. It's tuned for the sRGB colour space, covering 96% of that gamut with an average Delta E of 0.78. For this price, I'd have liked the whites to look whiter, higher peak brightness (365 cd/m² won't be enough for use in sunshine) and more pixels wouldn't go amiss, either, as text lacks sharpness.

Where it wins is support for touch: sometimes, prodding a dialog button is the easiest choice. HP provides a large, glass-coated touchpad for more conventional navigation, and it sits beneath a mixed keyboard.

In terms of action, the Elite x360 1040 is up there with the best laptop keyboards around. There's enough resistance to make typing a pleasure, all the important keys are suitably large, and I love its quiet nature: you'll need to thwack the keys hard to annoy neighbouring workers. But I was repeatedly tripped up by the half-height cursor keys, with Pg Up and Pg Dn immediately above the left and right arrows. It felt that whenever I hit a keyboard shortcut (such as Ctrl + left to go back one word) I hit the wrong button.

HP clearly believes that USB-C rather than USB-A is the future, with three of the former ports and only one of the latter. The right-hand USB-C port peaks at 10Gbits/sec thanks to its support for USB 3.2 Gen 2, but head to the left and you'll find a pair of even faster USB-C/Thunderbolt 4 ports. HP

ABOVE A low-energy touchscreen helps boost battery life



LEFT The Elite x360 1040 2-in-1 G11 is a highly practical laptop

"This is a well-built 2-in-1 designed for practicality, from its port selection to its battery life to its build quality"

BELOW There are three USB-C ports, two of which are fast Thunderbolt options

also sticks a 3.5mm jack and HDMI 2.1 connector here, but no physical Ethernet port. Wi-Fi 6E is your networking friend rather than the more forward-looking Wi-Fi 7.

While the CPU's AI abilities are stuck at a modest 34 TOPS – compared to 45 TOPS for the Snapdragons inside Copilot+ PCs – you can draw upon them when using the webcam, with Windows Studio Effects such as eye contact and background blurring at the ready. The 1440p webcam is top notch, other than a tendency to blow out highlights, and if you need to take photos it can snap at up to 2,560 x 1,440. The mics can use AI to dial down background noise, while the speakers are among the best I've

heard on a business laptop.

When it comes to ease of repair, this laptop is a delight. Remove four crosshead screws, slide a pick into the gap and the rear lifts off to reveal a replaceable Wi-Fi card, battery and SSD, though the memory is embedded onto the motherboard. And while the one-year warranty is to be expected, you can buy a Care Pack at any point during that year to extend it to up to five years of on-site cover. HP also provides its Wolf Security for one year, offering an extra layer of protection baked into the hardware.

With a 1.4kg weight and 14.7mm thickness – both above average for a 14in laptop due to the nature of convertible designs – the HP Elite x360 1040 G11 is not going to set pulses aflame with desire. Nor is its matte silver finish. But this is a well-built 2-in-1 designed for practicality, from its port selection to its battery life to its build quality. It's not an

exciting choice, but it is a safe – especially if you already manage a fleet of HP laptops. **TIM DANTON**

SPECIFICATIONS

16-core (6 P-cores, 8 E-cores, 2 LPE-cores) Intel Core Ultra 7 155H processor • Intel integrated Arc graphics • 32GB LPDDR5X-7500 RAM • 14in 60Hz IPS touchscreen, 1,920 x 1,200 resolution • 1TB M.2 PCI-E Gen4 SSD • Wi-Fi 6E • Bluetooth 5.3 • 1080p IR webcam • HDMI 2.1 • 2x Thunderbolt 4/USB-C 4 • USB-C 3.2 Gen 2 • USB-A 3.2 Gen 1 • 3.5mm combo jack • fingerprint sensor • 68Wh battery • Windows 11 Pro • 313 x 220 x 14.7mm (WDH) • 1.4kg • 1yr RTB warranty • part code, A26U8EA#ABU



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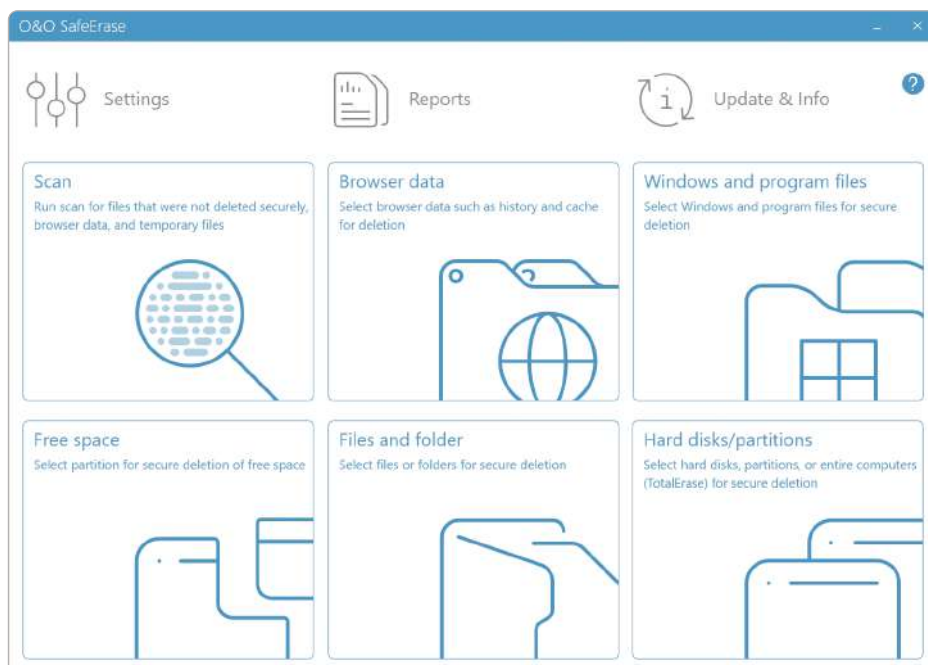
We scour the globe to negotiate the best software deals for our readers, from extended licences to full programs you don't need to pay a penny for. Here's this month's lineup

SafeErase 17 Professional

It's tempting to think that deleting a file means it's gone forever. But in reality, "deleted" data can hang around on your hard disk long after it's supposedly been wiped. This happens because when you erase a file Windows simply marks it as deleted, rather than actually removing it from your disk. The assumption is that the disk space will be overwritten sooner or later – but until that happens, anyone with rudimentary data recovery tools can dive in and resurrect your deleted data.

■ Full product worth £20
■ oo-software.com **REQUIRES** Windows 8.1 or later; 300MB hard drive space; online registration

O&O SafeErase Professional ensures that the items you want to delete really do get wiped. After marking files as deleted, it immediately overwrites their disk space with zeros – or you can use more thorough (and time-consuming) methods, recognised by the likes of the US Department of Defense, to ensure your data can't be recovered, by you or anyone else. The software can also ensure that previously deleted files can't be recovered, by overwriting the space where old data may still reside. Rather than laboriously wiping all the free

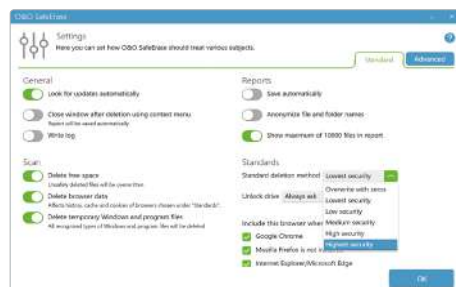


space on your hard drive, O&O SafeErase can focus only on potentially recoverable data, speeding up the process. If you're planning to sell or donate an old PC or hard disk, entire partitions or volumes can be wiped, starting from within Windows so you don't need to create any bootable media in advance.

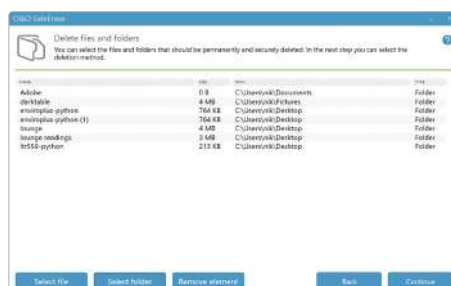
O&O SafeErase can also securely destroy all traces of your internet browsing, from cookies and downloaded files to the history of pages you've visited, with Internet Explorer, Edge, Chrome,

Firefox and Opera all supported. Insecure Windows and program files, such as temporary files and Flash Player cookies, can be purged too.

These powerful tools are accessed through a simple-to-use interface. Click "Start analysis", and O&O SafeErase will get to work; when it's finished, you can review its findings and clean up your computer with a single click, or use tools such as the SafeErase files and folders option for deleting selected files.



ABOVE SafeErase offers a choice of six deletion methods, so you can choose how secure you want to be and how long you're prepared to wait



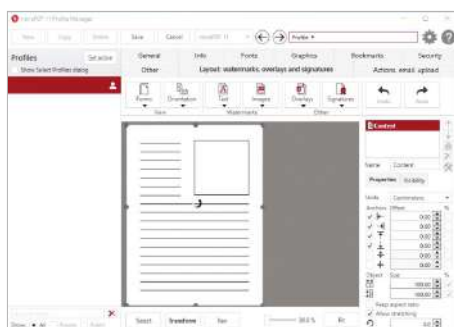
ABOVE You can use SafeErase to delete individual files and folders, as well as wiping complete disks and partitions



ABOVE As well as securing deleted files, SafeErase can wipe potentially sensitive data from Windows and your web browser

novaPDF 11.9 Lite

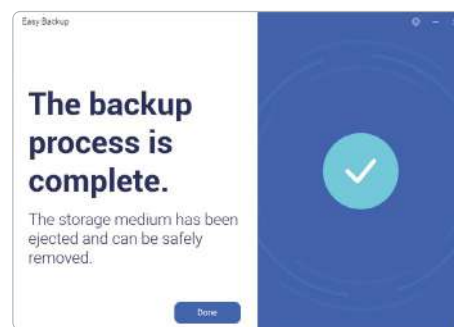
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- Open a document, choose print, and select the novaPDF virtual printer to convert your file
- Conveniently integrates with Microsoft Office via a dedicated novaPDF tab



■ Full product worth £29 ■ novapdf.com
REQUIRES Windows 8 or later; 100MB hard drive space; online registration

Easy Backup 2024

- User-friendly backup system: select the files you want to back up, pick a destination, and let Easy Backup do the rest
- Protect default user folders, or choose files individually
- To restore your data, simply choose the data of the backup set you want to recover



■ Full product worth £20 ■ abelssoft.net
REQUIRES Windows 7 or later; 50MB hard drive space; online registration

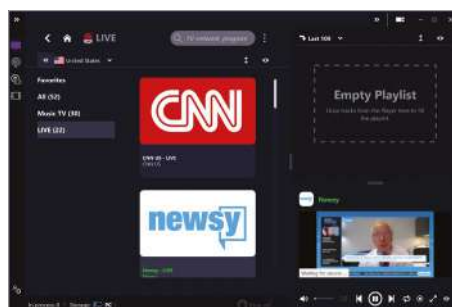
Secure Eraser 6.1



■ Full product worth £28 ■ ascomp.de
REQUIRES Windows Vista or later; 50MB hard drive space; online registration

- Securely delete sensitive data by overwriting the disk space they occupy several times
- Choose individual files for removal, then apply your preferred level of security, right up to standards used by governments
- Alternatively, securely wipe an entire drive before giving away or selling an old computer

TV Recorder 2024.1



■ Full product worth £10 ■ audials.com
REQUIRES Windows 10 or later; 200MB hard drive space; online registration

- Record streaming TV to your hard drive or SSD to watch whenever's most convenient
- Search for shows using keywords to track down the content you're after
- Filter channels by country, type and language; watch in a small window while working, or full screen when relaxing

Music Studio 2024



■ Full product worth £25 ■ ashampoo.com
REQUIRES Windows 8 or later; 200MB hard drive space; online registration

- Build, manage and share your music collection. Rip tracks from CDs or record using your PC's mic or line-in port
- Strip soundtracks from videos and save them as audio files in WMA, OGG and WAV formats
- Rename and organise your files in a logical folder structure, burn audio CDs and design CD covers

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Motorola Razr 50 Ultra

Improvements in every key area make this the best foldable phone on the market, despite its iffy AI



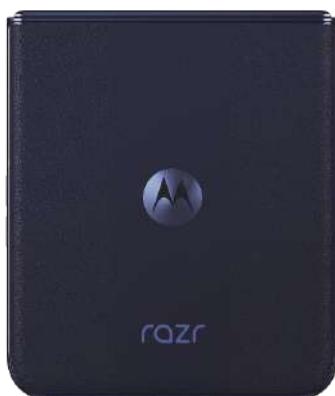
SCORE ★★★★★

PRICE £833 (£1,000 inc VAT)
from motorola.co.uk

Motorola's latest high-end flip-phone is competitively priced. At £1,000 inc VAT it costs the same as an iPhone 15 Pro, and more importantly £50 less than its direct rival, Samsung's Galaxy Z Flip6 (see p73). So the question is: has anything been sacrificed?

It's certainly not style. In fact, I'd argue that the Razr 50 Ultra is the coolest phone you can buy. It comes in four colours that are as striking as the names Motorola gives them, namely Spring Green, Midnight Blue, Peach Fuzz and a Hot Pink that's a throwback to 2005's pink Razr V3. Everything about the design is thoughtful and slick, from the soft, suede-effect "vegan leather" (ie, plastic) back that shows off the paint job nicely, to the humongous cover display – but more about that later.

It feels great in the hand, too. I found the size and weight very comfortable, whether the phone was opened or closed, and the folding mechanism snaps open and shut



so satisfyingly that it becomes addictive. An IPX8 rating means it can take a dunk underwater without issue.

The specs are not to be sniffed at, either. The UK model has 12GB of RAM as standard, plus a roomy 512GB of built-in storage, and is powered by Qualcomm's shiny new Snapdragon 8s Gen 3 chipset. It's a very tempting package with – as we'll see – only a handful of shortcomings.

■ Displays outside and in

The most immediately striking thing about the Razr 50 Ultra's design is its full-face cover display. It's conspicuously bigger than the outer screen on last year's Razr 40, and than the display on the Samsung Galaxy Z Flip6. As well as offering a decent amount of space for apps, it's so sharp and bright – it's rated at a maximum of 2,400cd/m² – that it's a joy to use in its own right.

The only catch with the outer display is the two holes punched out for the camera lenses, plus a third smaller one for the flash. I like the way the screen flows around the cameras, but it can cause practical obstacles – for example, some of the buttons on the Roku TV remote app were inaccessible.



ABOVE The Razr 50 Ultra is available in four vibrant colours

You can resize apps to fit better, but it's a chore; this isn't something that afflicts Samsung's Galaxy Z Flip6.

The foldable inner display is even brighter than the outer one, at 3,000cd/m². It looks just as good, and it opens out impressively flat: I couldn't even see the crease unless I held the phone at an angle, and I could barely feel it when I ran my finger across the screen.

■ Software sins

The Razr 50 Ultra runs Motorola's version of Android, but compared to other manufacturers the company has a light touch with customisations. The whole experience looks and feels a lot like using a Google Pixel, although

Motorola only promises three major OS updates, versus five from Google and Samsung.

Motorola does, however, make a number of interesting additions to the Android interface, notably its gesture shortcuts. For example, I love the way you can open the camera app by twisting your wrist a couple of times. This works even when the phone is closed, which means you can grab a

"As well as offering a decent amount of space for apps, the cover display is so sharp and bright that it's a joy to use in its own right"

LEFT The "vegan leather" back adds to the phone's good looks

selfie by simply applying a quick double twist of your wrist, then holding the phone up in front of you. I also like the way you can “chop” the phone twice in the air to toggle the front light on and off.

Sadly, not everything about Motorola’s Android platform makes such a good impression. The Razr 50 Ultra software includes an AI wallpaper generator, which can in theory generate any background you describe – giving you a much freer hand than you’ll get with Google or Samsung phones.

Unfortunately, the results clearly suffer from the sort of AI bias I thought we’d left behind years ago. If you ask for people you’re certain to get white people, while “friends at the beach” produced images of girls in bikinis, and “a strong person” got me a shirtless musclemán. Such stereotyping leaves a sour taste in the mouth – and you can’t just keep trying until you get results you’re happy with, as there’s a limit to how many wallpapers you can render in a month. There’s not even an option to buy more images; you must wait until the following month to have another go.

■ Camera tricks

The Motorola Razr 50 Ultra is fun to shoot with in almost every situation. As I’ve mentioned, you can grab selfies without needing to unfold the phone, by just twisting your wrist (or tapping the Camera app). Open the phone up for portraits and the cover display gives the subject a handy view of what the camera’s seeing; it’s great to watch friends smile when they see themselves on the cover screen.

You can also use the phone’s folding design to stand it up on its own, and start a countdown by raising a palm. My favourite feature is the ability to switch into “camcorder mode” by simply opening out the screen halfway and aiming the camera at the action. The Razr Plus starts recording video automatically, and you can stop with a tap anywhere on the bottom half of the screen.

As for image quality, photos and videos captured by the Razr 50 Ultra make a great first impression, with bright, rich colours – but I did hit a few issues in my testing. Focusing didn’t always hit the mark, especially with close-ups, even after I’d tapped on my desired focus point; and while I took care to use the digital level, my landscape photos sometimes came out crooked. I also felt that blurred bokeh backgrounds looked processed and artificial, without the smoothness you’d get from a full-sized camera lens. Still, the overall quality is fine for everyday casual snaps, and I’m inclined to

forgive a few foibles when the act of shooting is such a joy.

■ Performance and battery

The Snapdragon 8s Gen 3 chipset inside the Razr 50 Ultra is a middleweight model, delivering similar levels of performance to last year’s Snapdragon 8 Gen 2 (as in the Galaxy Z Flip5) but with lower power demands.

That means it can’t keep up with the Flip6, which includes the full-fat Snapdragon 8 Gen 3 chip: it scored 4,848 in Geekbench 6’s multicore test compared to 7,022 for the Flip6. But this remains a fast phone. My apps ran perfectly smoothly and snappily; even fancy tricks such as opening the camera with gestures, or moving an app from the big internal display to the smaller cover screen, worked without delay. The phone also did a great job playing games and movies, including high-resolution multiplayer games such as *Call of Duty: Mobile*.

The only hiccup I encountered was with Motorola’s AI features. Leaving aside my issues with the wallpaper generator, I found AI-enhanced features such as text editing and photo editing laggy, especially compared to similar features on the Pixel 8 Pro and Galaxy S24 – and sometimes tasks would fail completely.

It’s a clunky experience, but that may be down to first-generation software. Qualcomm claims the Snapdragon 8s Gen 3 has a generous amount of on-device AI processing power, and I found Google Gemini ran smoothly on the Razr 50 Ultra’s cover display (something you can’t do on the Galaxy Z Flip6). Motorola says that new AI capabilities will be coming to the phone in future updates, so here’s hoping that overall performance will also be optimised and improved.

BELOW The foldable inner display opens out to an almost imperceptible flatness



While the Razr 50 Ultra isn’t the fastest phone around, it’s admirably power-efficient. Its 4,000mAh battery is only 7.5% larger than the cell in the Galaxy Z Flip5, yet it achieves almost 50% more battery life. In our tests we regularly enjoyed more than 14 hours of screen time with the Razr 50 Ultra.

The phone supports fast 45W charging too, although there’s no charger included in the box, so if you want speedy top-ups you’ll need to source a suitable power supply separately. You can also recharge via a Qi2 wireless charger, although when I tried this I experienced an odd glitch where the screen woke up every few seconds while charging. Hopefully a future software update will fix this.

■ An open and shut case

If you’re sick of the same old smartphone designs, the Razr 50 Ultra is the perfect cure. Aside from the inherent appeal of the folding format, it’s bright and colourful inside and out, the king-sized cover display is both attractive and practical, and the hinge snaps open and shut with a terrifically pleasing action.

“It’s bright and colourful inside and out, the king-sized cover display is practical, and the hinge snaps open and shut with a pleasing action”

There are rough edges. The AI-powered image generator should never have been released with its current biases, and the other AI tools aren’t as snappy as they are on

other handsets.

Frankly, though, you can ignore the AI gimmicks and still find much to like about the Razr 50 Ultra. Perhaps the best reason to hold off buying this phone is that, historically, Motorola has a habit of offering great discounts on its top-end handsets once the initial launch period has passed – and often also adds new colours to the range, in partnership with Pantone. Even at full price, though, the Razr 50 Ultra is a decent deal in a selection of great-looking finishes. It’s an easy recommendation for anyone looking to take a walk on the flip-side. **PHILIP BERNE**

SPECIFICATIONS

8-core 3GHz/2.8GHz/2GHz Qualcomm Snapdragon 8s Gen 3 • 12GB RAM • Adreno 735 graphics • 6.9in foldable 120Hz AMOLED screen, 1,080 x 2,640 resolution • 4in AMOLED 165Hz cover screen, 1,272 x 1,080 resolution • 512GB storage • IPX8 • dual 50MP/50MP rear cameras • 32MP selfie camera • 5G • Wi-Fi 7 • Bluetooth 4 • USB-C 2 connector • 4,000mAh battery • Android 14 • open, 74 x 7.1 x 171mm (WDH); closed, 74 x 15.3 x 88mm (WDH) • 189g • 1yr warranty



LEFT The superb outer display is extremely bright and highly practical

Motorola Razr 50

A huge improvement over the Razr 40, setting a new benchmark for foldable phones in this price range

SCORE ★★★★★

PRICE £667 (£800 inc VAT)
from motorola.co.uk

If the Razr 50 Ultra is too pricey, Motorola also offers a regular version of its latest flip phone. At only £800 inc VAT it's the cheapest of the current generation of foldables, yet it manages to match much of the style and appeal of the Ultra.

It too comes in a cool choice of colours, ranging from sober Koala Grey through tasteful Beach Sand to Spritz Orange. The vegan leather casing remains, with its contoured edges and lightweight feel, and the updated folding mechanism opens and closes with a satisfying snap.

The Razr 50 also has a generously sized cover screen, with the same two punched-out holes for the camera lenses. It doesn't quite cover the entire front of the phone as the Ultra's does, but it's big enough to be both useful and attractive, with a 90Hz refresh rate and a sharp 413ppi pixel density. You can happily capture selfies with the rear cameras, use the half-unfolded phone as a desk display and even run full apps without opening up the case. It's protected by a Gorilla Glass Victus coating, and the whole thing boasts an IPX8 water resistant design.

The 6.9in OLED inner display looks great, too. This has the same sharp density as the outer screen, a smooth 120Hz refresh rate and a maximum brightness of 3,000cd/m², making it a joy to use even in direct sunlight. The crease is visible, but less so than on older flip phones.

One significant difference between the Razr 50 and the Ultra is that this model doesn't have a telephoto lens, instead pairing a decent 50MP main camera with a 13MP ultrawide. I prefer this arrangement for vlogging, selfies and group photos, as the ultrawide lets you capture more of the scene, while an upgraded photo booth mode works with both the inner and outer displays. In camcorder mode the Razr 50 can capture 4K video at up to 60fps, in either vertical or horizontal positions, although there's no HDR support.



BELOW/LEFT The outer screen has a 90Hz refresh rate and a sharp 413ppi pixel density



The Razr 50 also benefits from the AI enhancements to improve photo quality and stabilise your videos, and when I compared image quality between this phone and the pricier Razr 50 Ultra I couldn't see much difference. The colours are more subdued and dynamic range isn't as good in the shadows, but the Razr 50 still produces fine photos. The biggest compromise is the all-digital zoom; it works pretty well, but look closely and zoomed-in images are smudgy compared to those taken with the 50 Ultra.

Another noteworthy difference between the Razr 50 and the Ultra is the processor. In place of the Ultra's Snapdragon chip, the standard Razr uses a MediaTek Dimensity 7300X chip, which is a mid-range performer. It's also backed up by a more modest 8GB of memory and 256GB of UFS 2.2 storage.

Even so, apps run smoothly, and in everyday use I barely noticed any difference between this phone and the Ultra. While it got a little hung up during intense battle scenes in *Age of Origins*, gaming is certainly achievable.



Indeed, there's an optional Turbo mode to eke out the best gaming performance possible, at the expense of battery life.

I'm pleased to see all of Motorola's software enhancements here, too. I love the personalisation options for the outer display, and the gestures such as chopping to instantly turn on the torch. The Razr 50 also includes Google Gemini, which can be accessed directly from the external display, but it's worth noting that this phone won't get the full set of future Moto AI

features that are supposed to be coming to the Ultra. At this point it's difficult to say how much that matters, but it could become frustrating over the lifetime of the phone. On that point, the Razr 50 also has a comparatively short software support period, with Motorola promising only three years of major Android updates.

One thing the Razr 50 isn't short of is battery life. In our rundown test it managed an excellent screen-on time of 14hrs 37mins – almost half an hour longer than the Ultra – and in real-world use I've found it generally ends the day with a remaining charge of around 35%.

"It offers a great outer screen, an attractive design, decent performance, strong battery life and a pretty positive camera experience"

For recharging, the Razr 50 supports fast 30W charging, which got me from zero to 58% in half an hour, plus 15W wireless charging for cable-free top-ups.

In all, the Razr 50 is an impressive proposition. Sure, it's not the greatest flip phone in the world: if you want optical zoom, top-tier gaming performance and the full set of AI features you'll need to pay the extra for the Ultra. Even so, the Razr 50 offers a laundry list of plus points, including a great outer screen, an attractive design with water resistance, decent performance, strong battery life and a pretty positive camera experience. For the price, it's a fantastic deal. **JOHN VELASCO**

LEFT The outer screen comes into its own when you're taking photos of friends



SPECIFICATIONS

8-core 2.5GHz/2GHz MediaTek Dimensity 7300X • 8GB RAM • Mali-G615 MC2 graphics • 6.9in foldable 120Hz AMOLED screen, 1,080 x 2,640 resolution • 3.6in AMOLED 120Hz cover screen, 1,056 x 1,066 resolution • 256GB storage • IPX8 • dual 50MP/13MP rear cameras • 32MP selfie camera • 5G • Wi-Fi 6E • Bluetooth 5.4 • USB-C 2 connector • 4,200mAh battery • Android 14 • open, 74 x 7.3 x 171mm (WDH); closed, 74 x 15.9 x 88mm (WDH) • 188g • 1yr warranty

BELOW At only 15.9mm thick when closed, the Razr 50 is eminently portable

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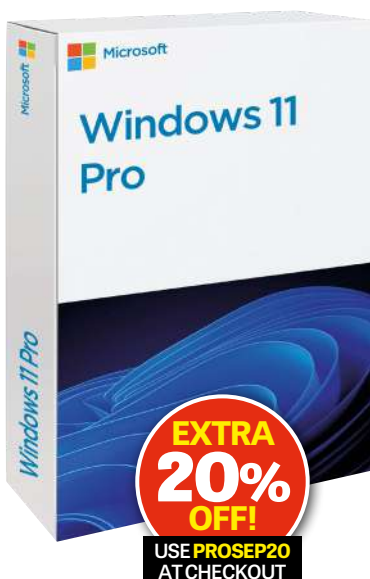
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One new CCleaner 6 feature is its Performance Optimizer. Unlike optimisation techniques found in other apps, the boost given by this can be measured in benchmarks. Performance Optimizer uses a three-step process, where it detects the apps and services you have running, along with background tasks and processes. Anything it deems unnecessary is put into sleep mode until it's needed. The result: better performance, better battery life on laptops.

We also like CCleaner 6's improved software updater, which does a great job of ensuring the very latest versions of apps and drivers are installed. And it doesn't stop there, also including security tools such as a data eraser so you can make sure files and information are completely removed from your PC.



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Samsung Galaxy Z Fold6

It's lighter, faster and more durable than the Fold5, and includes powerful AI tools – shame about the price

SCORE ★★★★★

PRICE 256GB, £1,499 (£1,799 inc VAT)
from [samsung.com](https://www.samsung.com)

While flip phones are hardly cheap at around £1,000, fold-out handsets still command a premium. In the case of the Galaxy Z Fold6, that's £1,799 for the base specification with 256GB and 12GB of RAM. This is a phone with plenty to justify.

It certainly looks like a high-end device. The Silver Shadow, Pink and Navy finishes are all stylish, with purist black and white options also available direct from the Samsung website. I also like how it feels in the hand: Samsung has cut some of the heft from previous models, so the Z Fold6 now weighs about the same as an iPhone 14 Pro Max.

The thickness has been shaved down, too, so when closed the Z Fold6 is 12.1mm thick, down from 13.4mm. Mind you, the Honor Magic V2 (see issue 355, p70) is 9.9mm and costs £1,200. The Fold6's flat-edge design can dig into your hand, but overall it feels refined and compact despite being more robust than previous models, with tougher glass layers and a strengthened hinge.

The cover display is also larger than on previous models. It's a small change, only going from 6.2in to 6.3in, but it feels more spacious and easier to type on. The internal 7.6in display, meanwhile, has less of a crease than the Z Fold5, and can go super bright – I measured a maximum of 2,317cd/m², which blows away the Z Fold 5's 1,535cd/m². Colour performance is great, with bags of vibrancy and 97% coverage of the DCI-P3 colour space.

Predictably, the user experience is loaded with AI features, including



Google Gemini and several Samsung-specific AI tools. A fun one is Sketch to Image in the Samsung Notes app, which can turn a freehand doodle into a watercolour, illustration, sketch, pop art or 3D cartoon. There's also Note Assist, which can transcribe and summarise meetings. I tried this on a 40-minute call, and while the AI took a few minutes to process the discussion, it generated an impressively clear and accurate summary.

I also like the Interpreter app, which translates conversations in real-time, using the main and cover display together so both you and the person you're speaking with can see what's being said. It even works offline.



The Snapdragon 8 Gen 3 inside the Z Fold6 provides plenty of oomph for

running apps side by side, or for intense big-screen gaming – while playing the frenetic *Diablo Immortal* I found the action stayed perfectly smooth, even with a ton of enemies on the screen. In the Geekbench 6 benchmark the Z Fold6 achieved a single-core score of 2,170 and a multicore result of 6,901, ranking well ahead of rival foldables such as the Magic V2, which managed 1,912 and

4,338, or the OnePlus Open (see issue 351, p60) and its returns of 1,552 and 4,935.

While there's lots to like about the Z Fold6, it has limitations. For one, while the construction quality is improved from previous generations, the IP48 rating means it's still vulnerable to particle intrusion. I'd hesitate to take this phone to the beach.

Battery life could be better, too. The Z Fold6's 4,400mAh battery lasted 10hrs 35mins in our tests, while Samsung's non-folding Galaxy S24 handsets managed over 14 hours. Even among folding phones the Z Fold6's longevity is unexceptional, with the OnePlus Open surviving almost an hour longer at 11hrs 31mins. The Galaxy Z Fold6 supports 25W fast charging, so I could charge back up to 56% in 30 minutes – but it can't match the 67W charging of the OnePlus Open, which reached 50% in only 15 minutes.

A final compromise is the Galaxy Z Fold6's camera array.

To be clear, this isn't bad at all: you get the same 50MP main camera as on last year's model, plus a 12MP ultrawide camera and a 10MP telephoto with 3x optical zoom. I found my shots looked nice and crisp, with decent dynamic range, but they're not as obviously brilliant as the images you'll get from

the Galaxy S24 Ultra, with its 200MP main sensor and 5x zoom. Given the price, that's a disappointment.

Indeed, the price hangs over every aspect of the Z Fold6. It's £50 more than last year's model, and if

you want 512GB of storage that adds £100 to the price. The optional S Pen case is a further £89 on top of that.

This is certainly Samsung's best foldable yet, and if you're looking for a folding phone that's packed with AI smarts then it's your best choice until the next Pixel Fold comes along. But rivals are clear winners when it comes to value. **MARK SPOONAUER**

ABOVE A wider front display makes this a much more usable phone when closed...

"Samsung has cut some of the heft from previous models, so the Z Fold6 now weighs about the same as an iPhone 14 Pro Max"

LEFT ...and when you open it up, the 7.6in inner display looks fantastic

BELOW The Fold6 is slimmer than previous models, but still chunky at 12.1mm



SPECIFICATIONS

8-core (3.4GHz/3.1GHz/2.2GHz) Qualcomm Snapdragon 8 Gen 3 SoC ● 12GB RAM ● Adreno 750 graphics ● 7.6in foldable 120Hz AMOLED screen, 1,856 x 2,160 resolution ● 6.3in cover 120Hz AMOLED screen, 968 x 2,376 resolution ● 256GB/512GB/1TB storage ● triple 50MP/10MP/12MP rear cameras ● 10MP/4MP front cameras ● Wi-Fi 6E ● Bluetooth 5.3 ● 4,400mAh battery ● USB-C 3.2 Gen 2 connector ● Android 13, One UI 5.1.1 ● folded, 68 x 12.1 x 154mm (WDH); unfolded, 133 x 5.6 x 154mm (WDH) ● 239g ● 1yr warranty

Samsung Galaxy Z Flip6

New Galaxy AI features, a larger battery and a faster chip don't quite offset the Galaxy Z Flip6's higher cost

SCORE ★★★★★

PRICE 256GB, £874 (£1,049 inc VAT)
from [samsung.com](https://www.samsung.com)

Samsung is on its sixth generation of Galaxy Z Flip devices, and the newest version brings some decent updates, including a 50MP main camera and an upgraded front display. It also comes with a price hike, however, making it £50 more expensive than Motorola's excellent Razr 50 Ultra (see p68).

The basic design has a similar aesthetic to last year's Galaxy Z Flip5 (see issue 349, p70). The phone is still incredibly compact when closed, and its aluminium frame feels solid in the hand. The only visible difference this time around is that the outlines of the camera lenses are tastefully accented in the same colour as the phone.

Four standard trims are on offer, namely Silver Shadow, Yellow, Blue and Mint; order direct from Samsung and you can also buy Crafted Black, White and Peach. I like the pastel styling, and the matte finish that resists smudges and fingerprints, but I found the phone tricky to flip open, especially one-handed, thanks to its smooth, flat edges.

The "FlexWindow" cover display is the same size and shape as last year's model, with the same fin cutout on the bottom right where the display meets the cameras. You can use this 3.4in AMOLED touchscreen to swipe through various widgets while the phone's closed, and there's a new option to combine multiple items into one convenient homescreen. New interactive lock screens respond to touch and movement, but if you want to run full apps on the FlexWindow you must download Samsung's additional Good Lock app – an awkward extra step for a capability that ought to be built into the OS.

The inside screen, meanwhile, uses a 6.7in FHD+ Super AMOLED panel with a dynamic refresh rate of up to 120Hz. I measured a peak

brightness of 1,942cd/m², and while that's not as dazzlingly bright as the Motorola Razr 50 Ultra, the screen still looks great, with excellent contrast and punchy colours. The crease where it folds in the middle is impressively low key – it might well be the most inconspicuous I've seen.

One of the most notable upgrades in the Z Flip6 is the 50MP main camera – a huge step up in resolution from the 12MP camera on the previous model. This captures enough detail to provide a high-quality 2x digital zoom, without needing a dedicated telephoto lens.

The camera app offers all the modes you'd want, plus a Pro video mode with full manual controls and interesting extras such as hyperlapse, dual recording and portrait video. One of my favourite new features is AI Zoom, which automatically crops the frame to suit whatever or whoever you're shooting. There's also a new camcorder mode that lets you shoot with the phone folded in the halfway position, with zoom controls at your fingertips.

Image quality is very good, with lovely balanced exposures and bold colours. Low-light performance is a particular strength, and the digital zoom delivers results that look almost as good as optical telephoto images from other phones. The ultrawide camera, meanwhile, can capture more of a scene, or cram a lot of people into a group shot. If I had to criticise I'd note only that the phone can sometimes oversaturate colours, and the automatic sharpening could go a little further.

LEFT Both the internal and external screens are top quality AMOLED panels



"The crease where the screen folds in the middle is impressively low key – it might well be the most inconspicuous I've seen"



ABOVE The cover display has a cutout in the corner for the excellent cameras

LEFT The phone's smooth, flat edges make it tricky to open with one hand

The Z Flip6 uses a top-of-the-range Snapdragon 8 Gen 3, as found in Samsung's Galaxy S24 flagship phones. This ensures that everything you do feels impeccably sharp and snappy; benchmarks confirm it's a huge leap up from the Razr 50 Ultra and the Flip5, with Geekbench scores up to 60% higher. It tears through the most intensive games, and can even multitask two apps at once, with a third in a pop-up window, without a stutter. It's impressive stuff.

The underlying software is Samsung's One UI 6.1.1, running on top of Android 14. This comes with the same suite of Galaxy AI features introduced by the S24 series earlier this year, including Instant Slow-Mo, Generative Edit, Note Assist and Transcript Assist. Some of these are useful, others feel more like fun demos, but they're all nice to have. It also supports Circle to Search and Google Gemini, which works like a charm on the front screen.

Perhaps the most mediocre aspect of the Z Flip6 is its battery life. The internal 4,000mAh battery saw me through a typical day's use, but in our battery benchmark it delivered only 11hrs 1min of screen-on time – three hours less than the Motorola Razr 50 Ultra. Recharging is also limited to 25W wired and 15W on a wireless pad; I got up to 55% charge in 30 minutes, but other phones are much faster.

Overall, the Galaxy Z Flip6 is a charming phone. It's bursting with power, it takes great photos and it comes with a strong slate of Galaxy AI features. For sure, Motorola's latest flippers offer stiff competition at lower prices, but Samsung offers generous trade-in deals on older handsets – check the website and you may find this premium phone is much more affordable than you'd expect.

JOHN VELASCO

SPECIFICATIONS

8-core 3.4GHz/3.1GHz/2.9GHz/2.2GHz Qualcomm Snapdragon 8 Gen 3 ● 12GB RAM ● Adreno 750 graphics ● 6.7in foldable 120Hz AMOLED screen, 1,080 x 2,640 resolution ● 3.4in AMOLED 60Hz cover screen, 720 x 748 resolution ● 256GB/512GB storage ● IP48 ● dual 50MP/12MP rear cameras ● 10MP selfie camera ● 5G ● Wi-Fi 6E ● Bluetooth 5.3 ● USB-C 3.2 Gen 2 connector ● 4,000mAh battery ● Android 14 with One UI 6.1 ● open, 72 x 6.9 x 165mm (WDH); closed, 72 x 14.9 x 85mm (WDH) ● 187g ● 1yr warranty



OnePlus Nord 4

The metal housing dazzles, as does the large screen and long-lasting battery, but the camera's not the best

SCORE ★★★★★

PRICE 256GB, £399 (£479 inc VAT)
from oneplus.com

Low-cost smartphones are often pared-down versions of the manufacturer's headline offering, but the OnePlus Nord 4 has its own distinctive character away from the OnePlus flagships.

Its notable features include a big display and great battery life, but what really sets it apart from the crowd is a metal unibody design. It's made of aluminium alloy, with the only glass – aside from the screen – to be found around the horizontally arranged rear camera lenses. It's a bold look, although an IP65 rating means it's not as waterproof as the IP67 protection offered by the Google Pixel 8a (see issue 358, p74).

The phone comes in three colours and textures, or "Nordtones" as OnePlus brands them – the brushed Obsidian Midnight seen here, the wave-patterned Mercurial Silver and the matte Oasis Green. All three options look classy in the flesh.

At 163mm tall and weighing 200g, this phone doesn't fall into the compact category. In return, the display is a huge 6.7in AMOLED panel, continuing OnePlus' habit of offering max-sized screens at every price point. It looks great, as AMOLED panels always do, and also features OnePlus' Aqua Touch technology; this means the touchscreen remains usable when it or your hands are wet – something other phones struggle with. However, it isn't as bright and usable as the Pixel 8a under direct sunlight.

The Nord 4's cameras are a straightforward 50MP main camera and an 8MP ultrawide at the rear, plus a 16MP selfie camera at the front. Compared to the Pixel 8a, the Nord 4's main camera lacks dynamic range, with dark detail getting lost in the shadows, though the heavier contrast can produce more arresting images. There's also a general warmth to its colour reproduction that I found

attractive. The 2x digital zoom is achieved by cropping, so there's no smudging, but don't be fooled: you still lose out on fine detail compared to a real telephoto lens.

Switching to the ultrawide camera produces bright images, but at the expense of colour and detail compared to the Pixel 8a's equivalent camera. And, as the photo on the right gives away, that's it for rear-facing cameras.

In selfie mode, the Nord 4 had a respectable go at producing a professional-looking photo of me, complete with bokeh effects. However, it didn't cut around my glasses perfectly, and the separation between the background and my face was less dynamic than the Pixel 8a's.

The processor powering all this is a Snapdragon 7 Plus Gen 3, partnered with 16GB of RAM and 512GB of storage. This is less powerful than the Snapdragon 8-series chips found in premium handsets, but it still delivers a good chunk of performance: in the Geekbench 6 CPU benchmark the Nord 4 achieved a multicore score of 4,275, outpacing both the Samsung Galaxy A55 and the Pixel 8a, which scored 3,464 and 4,093 respectively.

The Nord 4 also impressed me in the 3DMark Wild Life Extreme graphics test, maintaining an average frame rate of 18.2fps, while the Samsung and Google phones only hit 5.4fps and 14.3fps respectively. I happily played *Genshin Impact* with high graphics settings at 60fps, without the phone struggling or even heating up significantly.

ABOVE The huge 6.7in AMOLED panel belies the Nord 4's low price

ABOVE Rear cameras consist of a 50MP main and 8MP ultrawide lens

"The display is a huge 6.7in AMOLED panel, continuing OnePlus' habit of offering max-sized screens at every price point. It looks great"

FAR LEFT The metal unibody design makes the Nord 4 look better than many flagships

Another great feature of the OnePlus Nord 4 is its huge 5,500mAh battery. Watching YouTube for three solid hours drained the battery by only 11% – one of the best results I've seen. For comparison, the Samsung Galaxy A55 lost 22% of its battery during this test, while the Pixel 8a depleted by 18%.

When the battery did finally die, ultra-fast 100W recharging got me back up to 70% in only 15 minutes, with 100% achieved in under half an hour. There's no power supply included in the box, however, so to get these amazing speeds you must pay an extra £40 for the OnePlus Supervooc charger. There's no support for wireless charging.

As for the system software, OnePlus hasn't plunged head-first into AI like some other brands, but the Nord 4 comes with a sprinkling of practical AI powers, such as audio text summaries, text translation and AI cell reception boosting. Perhaps the most ambitious one is "AI Groupfie", a Pixel-style camera option that picks and pastes faces from similar shots so everyone in frame looks their best. However, this is coming post-launch, so I haven't yet had a chance to try it out.

On the topic of future support, OnePlus promises four years of full updates and six years of security updates. That's not as long as the seven years offered by the Pixel 8a, but I wouldn't feel cheated if I got four years of good service from a sub-£500 phone.

In all the Nord 4 is an attractive, efficient and hardware-generous phone. The Google Pixel 8a offers longer software support and better photographic credentials, but the Nord 4's low price and slick looks are undeniably persuasive – indeed, there's a 128GB version for only £429, which will be fine for many people.

It's a fantastic deal for a phone that does so much, and which arguably looks and feels better than many of the latest "flagship" phones.
RICHARD PRIDAY

SPECIFICATIONS

8-core 2.8GHz/2.6GHz/1.9GHz Qualcomm Snapdragon 7+ Gen 3 SoC • 12GB/16GB RAM • Adreno 732 graphics • 6.7in 120Hz AMOLED screen, 1,240 x 2,772 resolution • 5G • 256GB/512GB storage • IP65 • dual 50MP/8MP rear cameras • 16MP front camera • Wi-Fi 6 • Bluetooth 5.4 • NFC • 5,500mAh battery • USB-C 2 • Android 14 with OxygenOS 14.1 • 75 x 8 x 163mm (WDH) • 200g • 2yr warranty

Amazon Echo Spot (2024)

An excellent choice for anyone who wants a smart speaker for their bedside with limited distractions

SCORE ★★★★★

PRICE £67 (£80 inc VAT)
from amazon.co.uk

Amazon's original Echo Spot was discontinued in 2019, but it has been resurrected, with a new look and an updated feature set that expands on the first-generation design in some ways and streamlines it in others.

The slanted design of the new Spot is clearly inspired by the Echo Pop (see issue 348, p63). However, while the front of the Pop is one big speaker, the top half of the Spot houses a colourful 2.8in LCD touchscreen, with a resolution of 240 x 230 pixels. That may not sound like a lot, but on a display this small it's enough to ensure that text and icons look sharp.

Below the screen sits a forward-facing 1.7in speaker; flip the Spot around and you'll find the power port and an array of microphones lining the back, enabling it to hear commands from all angles. On the top sit physical volume and microphone mute buttons for instant control. It's a neat design: the 4.5in-wide body will fit comfortably into a bedroom or a compact office space, and the black, glacier white and ocean blue colour options all look classy.

Setting up the Echo Spot is easy, assuming you already have the Alexa smartphone app. Just plug in the device and use your smartphone to scan the QR code that pops up on its display; the app will guide you through the rest of the process. One key decision you'll need to make at this point is which clock face style to use: there are six to choose from, in a range of colours, and you'll want to pick one that suits your personality as you'll be seeing a lot of it – the Spot's screen remains awake at all times, showing either the clock or information such as timers, weather alerts and album artwork.

With night mode activated (either manually or by setting a schedule), the display switches to a dark mode with muted colours, and you can also toggle settings such as Do Not Disturb from within the Alexa app.

As usual, you can connect the Spot to any Bluetooth audio source, or access streaming services including Spotify, Amazon Music and Apple Music. Considering the small size of the speaker, audio quality is impressive, with great clarity and surprising warmth. Naturally, though, the bass response isn't as rich and powerful as you'll get from a larger speaker. If you like your thumps you'll be happier with a full-sized Echo.

As for practical features, the Spot works brilliantly as an alarm clock, dimming its display automatically when the room is dark. As with all Alexa devices, you can set a morning alarm with a single voice command; in the morning, if you're not feeling vocal, you can snooze or cancel the alarm with a tap on the Spot's screen.

The touchscreen has other uses, too. I liked being able to tap on the notification bell to hear updates, and to control my Alexa-compatible smart home devices. You can pull up direct touch controls for your smart lights and smart thermostat, so you don't have to disturb the person

ABOVE Text and icons look sharp on the colourful 2.8in LCD touchscreen

ABOVE Physical buttons on the top provide instant control

"Considering the small size of the speaker, audio quality is impressive, with great clarity and surprising warmth"

LEFT The display dims automatically when the room is dark

BELOW The compact body fits well on a bedside table or onto an office desk

next to you if you wake up freezing in the middle of the night.

I was, however, disappointed to find that the Spot doesn't have a temperature sensor of its own, so you can't set it to adjust the thermostat automatically, unless you partner it with a separate probe. The cheaper Echo Dot with Clock (see issue 341, p64) has this sensor built in, so it's a surprising omission here.

The Spot also lacks the Dot's ability to act as a range extender for Amazon's Eero Wi-Fi mesh systems – and, unlike the original model, the 2024 Spot doesn't have a camera, so you can't make video calls or use the device as an ersatz security monitor (although the standard drop-in and Alexa calling functions are supported). The Spot also can't stream video from Amazon Prime, Netflix or YouTube like Amazon's Echo Show devices can, although considering the size of the screen that's probably not going to be a deal-breaker.

On the plus side, the new Spot does support Amazon's ultrasound motion-detection feature, which the old one didn't. This makes it possible to create routines that are triggered by movement – for example, to turn on the lights when someone walks into a room, and turn them off again when no activity is detected for a certain period. I tried this out and was impressed by how quickly and accurately the Spot detected both my presence and absence.

The Echo Spot was always an unsung hero of the Echo range, and

it's great to have it back.

If you like the idea of a smart speaker that offers visual information and touchscreen controls in a format that's cheaper and more compact than an Echo Show or other smart

display, it's the perfect solution.

It's a shame that the new Spot isn't as smart as some other Echo products, but such economies have allowed Amazon to drive down the price: where the original Echo Spot launched at £120, the new model is a full third cheaper, making it an affordable and attractive smart speaker that deserves a place on anyone's night-stand or worktop. Add the usual Amazon discounts during Prime Days and other promotions, and it's even more compelling – recently selling for a mere £50. **HUNTER FENOLLLOL**

SPECIFICATIONS

Bluetooth speaker with Alexa • 1.73in front-firing speaker • 2.8in LED touchscreen • Wi-Fi 5 • Bluetooth LE with A2DP • supports Matter • 113 x 103 x 111mm (WDH) • 405g • 1yr limited warranty





SanDisk Desk Drive (8TB)

A high price, and it needs a power supply, but also a storming performer

SCORE ★★★★★

PRICE 8TB, £553 (£664 inc VAT)
from westerndigital.com

In our recent roundup of portable SSDs (see issue 357), only one went up to 8TB: the Samsung T5 Evo. Now SanDisk has released the Desk Drive in 4TB and 8TB capacities, and while the T5 Evo and SanDisk Desk Drive match each other for capacity and price, they're very different.

For a start, the T5 Evo is designed to travel with you, while the Desk Drive is meant to be tethered to your main computer. And to a power supply, as it only works when plugged in. This drive is substantially bigger too, with the footprint of a drinks coaster but roughly 4cm tall. It also comes with a key piece of software: Acronis True Image WD. This is a tailored version of the full software that costs around £30 per year, but here the licence lasts for five years from the date of installation.



If you use a Mac, the Desk Drive simply supports Time Machine.

During those five years, Windows users benefit from automatic or manual backups of their PCs, and it's a speedy operator: it took 17 minutes to back up the 238GB of files stored on my laptop. It also actively protects you against ransomware, scanning for third-party processes that it suspects are trying to encrypt your files.

The drive connects via USB-C (or USB-A via the provided adaptor) and needs a USB 3.2 Gen 2 port to reach its maximum quoted speeds: 1,000MB/sec sequential reads, 900MB/sec writes. In practice, it's way faster than the T5 Evo across every test: it scored 1,357 in PCMark's Data Drive benchmark versus 455 for the T5 Evo, which is closer to the 405 scored by

ABOVE The Desk Drive is a capacious and speedy SSD

"It actively protects you against ransomware, scanning for third-party processes it suspects are trying to encrypt your files"

the WD hard disk below. And it went beyond its official ratings in our tests, returning 1,014MB/sec sequential writes and 1,049MB/sec reads.

It proved less exceptional in real-world tests, returning scores of 784MB/sec reads and 534MB/sec writes. That's still roughly twice as fast as the T5 Evo, though, and notably the WD hard disk below stuttered to 109MB/sec and 96MB/sec in the same tests. The SanDisk Desk Drive also proved remarkably consistent when hammered in Iometer, indicating the quality of the electronics that sit inside this bulky unit.

There are cheaper ways to protect your data, with external hard disks and NAS drives both likely to offer more for your money. And unless you're going to use all the capacity, the 4TB version offers better value at £360 inc VAT as that still includes the

five-year licence for True Image. But if you're simply looking for peace of mind, and you have a huge amount of data to protect, then this does the job nicely. **TIM DANTON**

SPECIFICATIONS

4TB/8TB capacities • USB-C 3.2 Gen 2 (10Gbits/sec) • up to 1,000MB/sec sequential reads • 122 x 73 x 44mm (WDH) • 260g • 3yr warranty

Western Digital My Passport (6TB)

6TB of hardware-encrypted data for less than £200, but don't expect fast speeds

SCORE ★★★★★

PRICE £136 (£163 inc VAT)
from westerndigital.com

After years of capacity stagnation at 5TB, Western Digital recently upped its top-capacity portable hard drives to 6TB. Here, I'm testing the 6TB My Passport, but the gaming-focused WD Black and more basic Essential line benefit from the same capacity bump. It comes with an increase in height, too, with the 6TB model measuring 20.6mm thick to the 5TB drive's 19.2mm, suggesting a platter has been added to the drive inside.

The drives come with a plastic shell that's grey on the bottom, but with a top lid that's available in white, red, blue or black if you choose the "normal" model. This ships with an 18-inch cable that's USB-A on one end

but USB Micro-B on the other. Yes, the 5Gbits/sec connector that I would have expected on a drive in 2014 rather than 2024. If you want USB-C then choose the My Passport labelled "Works with USB-C" on Western Digital's website, and calmly accept the fact it only comes in grey. Even in other colours, it isn't the most beautiful drive, nor the lightest at 210g. Admittedly, SanDisk's Desk Drive above is even bigger and heavier – and requires a separate power supply, which this drive doesn't.

Western Digital includes utilities for both PCs and Macs, but the Windows installer didn't work on my drive. Luckily, you can grab the three programs individually from the support site. WD Security manages the drive's 256-bit AES hardware encryption/password, WD Drive Utilities lets you test the drive for failure issues and even turn off the tiny activity LED, but the best-value inclusion is a five-year licence for Acronis True Image – exactly what you get with the far more expensive SanDisk Desk Drive.



ABOVE It's not the sleekest design, but WD's My Passport is terrific value

"The My Passport trails SSDs in most of our tests. But keep in mind that this 6TB unit costs less than a 2TB portable SSD"

Obviously, as a hard drive, the My Passport trails SSDs in most of our tests. But keep in mind that this 6TB unit costs less than a 2TB portable SSD, while the 6TB Samsung T5 Evo and SanDisk Desk Drive cost over £600. We cover most of the My Passport's scores in the review above, but I'll flag its lowly 405 in PCMark 10's Data Drive benchmark and 109MB/sec sequential writes in DiskBench. You'll be kept waiting a long time if you need to fill its full 6TB capacity.

For sheer value, this high-capacity portable hard drive remains a compelling alternative to SSDs. However, the 5TB version costs £131 inc VAT, so if you don't need that last terabyte, consider saving yourself £32 by opting for a slightly smaller capacity. **MATT SAFFORD**

SPECIFICATIONS

6TB external hard disk • USB-B 3.2 Gen 1 (5Gbits/sec) • up to 110MB/sec sequential reads • 74 x 107 x 21mm (WDH) • 210g • 3yr warranty

AOC Q27B3CF2

What's not to like about a 1440p 27in IPS display with a USB-C port for £200?

SCORE ★★★★★

PRICE £167 (£200 inc VAT)
from amazon.co.uk

Monitors can have the fanciest features in the world, but ultimately there are four things that matter: image quality, resolution, connectivity and price. So while I'll tell you up front that the AOC Q27B3CF2's onscreen display is hard to navigate and its features are stripped back to a bare minimum, the key is that its 27in IPS panel delivers strong colours with accuracy, packs 2,560 x 1,440 pixels and includes a USB-C connector – all for £200.

I say strong colours, but I don't say a wide colour gamut: by modern standards 82% of the DCI-P3 colour space isn't wide. However, I'd be very happy to use this as my everyday monitor because photos and videos still look great, and its colour accuracy is exceptional, with an average Delta E



ABOVE The Q27B3CF2 isn't stuffed with features, but image quality is great

of 0.25. You can switch to sRGB if you want purer whites, although you will curse the aforementioned OSD while doing so.

Other monitors also go brighter than the 370cd/m² I measured, but that's far beyond what most people need: stick to 200cd/m² (around 70% in the monitor's settings) and you'll also reduce your power demands from the maximum 27W to a more sensible 17W. A contrast ratio of around 1,600:1 adds extra punch, but what separates this monitor from £200 rivals is that 1440p resolution – which is the perfect match for a 27in diagonal.

Features are barer than a politician's lies, but you get what matters: HDMI

and USB-C ports (the latter delivers up to 65W of power), an adjustable height stand and a 100Hz refresh rate. It also supports adaptive sync and a sub-1ms response time, so gamers should find much to enjoy here. There's even a pair of tinny speakers, but the two USB-A ports are more welcome.

The ports are tucked away at the rear, and with no swivel or pivot you won't find them easy to access. Also, a warning to those considering buying two or three Q27B3CF2s for a multi-monitor setup, especially if they see the phrase "ultra narrow" borders on AOC's website. They are narrow-ish, at 10mm, but that means a 20mm gap between screens if you place them side by side.

"Photos and videos look great here, and its colour accuracy is exceptional, with an average Delta E of 0.25"

Despite this, I would be tempted to buy two or even three of these monitors at this price. For £200, the AOC Q27B3CF2 is one of 2024's true bargains. **TIM DANTON**

SPECIFICATIONS

27in 2,560 x 1,440 IPS panel • up to 100Hz refresh rate • 8-bit panel (16.7 million colours) • 1ms MPRT response time • HDMI 2 • USB-C (65W power delivery) • 2 x USB-A 3.2 Gen 1 • 3.5mm headphone jack • 2 x 2W speakers • -5° to 25° tilt • 110mm height adjustment • 617 x 230 x 400-510mm (WDH) • 5.5kg • 3yr RTB warranty

Logitech Brio 105 for Business

A basic 1080p webcam, but it delivers for image quality even in low light

SCORE ★★★★★

PRICE £38 (£45 inc VAT) from logitech.com

One of the biggest challenges for Logitech is that its webcams are expensive compared to no-name rivals on Amazon that have similar specifications. As a recent example, consider the £219 MX Brio 705 for Business (see issue 356, p68) I reviewed four months ago.

Admittedly, that was a top-end device packed with features and capable of 4K streaming at 30fps. The Brio 105 is a more modest offering that's limited to 1080p and a 58° field of view (the Brio 705 offers a choice of three FoVs). But in practice, how much resolution and flexibility do most people need? If it's only you, sitting at your desk, attending a meeting, 1080p is absolutely fine, and a 58° FoV will place you large in the frame.



ABOVE The Brio 105 is a cheap and cheerful webcam that's ideal for home working

More to the point, image quality is excellent. Not just in strong light, but also when I turned off my office light at night and relied on my screen's backlight. The Brio 105 still did a fine job, without any amateurish artefacts.

The other plus side of buying from Logitech is that the Brio can be managed from Logitech's mature software, whether Logi Options+ for individuals or Logi Tune for businesses (you can deploy it using Logitech Sync). There's also a three-year warranty, while the webcam has been certified for Google Meet and Works with Chromebook – and it will naturally work on Windows

and macOS with all the usual conferencing platforms. Logitech takes sustainability seriously, too, promising that the plastic parts are made from 77% post-consumer recycled plastic and that this is a carbon neutral product.

From a practical point of view, it's good to see a basic but functional plastic shutter that you can slide over the lens when not in use, and while the single mic lacks any advanced features, I found it worked fine in a home office environment.

"Image quality is excellent. Not just in strong light, but also when I turned off my office light and relied on my screen's backlight"

The Brio is light enough to sling into a bag, but the whole assembly will come with you as the 1.5m USB-A cable is captive rather than detachable, as is the basic two-part mechanism to keep it in place atop your screen.

Of course, you can save cash by buying a £15 webcam with the same specs. But it won't perform as well in low light and definitely won't be as easy to roll out and manage for businesses. **TIM DANTON**



SPECIFICATIONS

2MP CMOS image sensor • 1080p streaming at 30fps • 58° field of view • omnidirectional mic • 1.5m cable • USB-A connector • 73 x 66 x 31mm (WDH) • 75g • 3yr warranty



VPNs

Whether you want to secure your web browsing, stream video from the country of your choice or choose the best free

VPN, our test of ten top services holds the answer

One of the most difficult tasks in a VPN Labs is to work out how good value each product is. You could spend hours comparing costs, as variables include not only the number of devices but also whether you buy monthly, annually or even on a three-year deal. And in most cases, you'll then be hit by the dreaded renewal fee, often significantly higher than the first year's charge that lured you in.

We've done our very best to make it easier for you by splitting the costs in various ways in our feature table overleaf and in the graphs on p94. In particular, you can see at a glance which service offers the lowest cost per month – but note that this involves a substantial up-front investment. For those who don't want to spend a penny, we also provide a take on the best free VPN providers on p93.

Then there's the tricky matter of gathering the speed data. Fortunately, we have years of historic speeds to draw upon as well as the latest results, and we take all this information into account when we decide our award winners. We also use less quantifiable data, such as how much each vendor can be trusted. We know this as we study it through leaks and news stories throughout the year.

All we can do now is hope that you find our test useful. So read on and discover which VPN service best suits your needs.

CONTRIBUTOR: KG Orphanides

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	Avast SecureLine	ExpressVPN	Mullvad	NordVPN	Norton Secure VPN	
Overall rating	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	
Website	avast.com	expressvpn.com	mullvad.net	nordvpn.com	uk.norton.com	
Best deal	3yr £93 (£112 inc VAT)	1yr \$100 (£79)	Monthly sub only	£78 (£94 inc VAT) for 27 months	First year, 10 devices, £58 (£70 inc VAT)	
First year subscription ¹	£34 (£40 inc VAT)	\$100 (£79)	Monthly sub only	£54 (£65 inc VAT) for 15 months	1 device, £17 (£20 inc VAT); 5 devices, £25 (£30 inc VAT); 10 devices, £58 (£70 inc VAT)	
Monthly subscription price	✗	\$13 (£10)	€5 (£4.22)	£10 (£12 inc VAT)	✗	
Renewal price	£67 (£80 inc VAT)	\$100 (£79)	€5 per month	£66 (£79 inc VAT)	1 device, £34 (£40 inc VAT); 5 devices, £50 (£60 inc VAT); 10 devices, £67 (£80 inc VAT)	
Lowest price per month in GBP inc VAT	£3.11	£6.55	£4.22	£3.40	£1.67	
Anonymous payment options	✗	Cryptocurrency, gift cards	Cash, cryptocurrency, gift cards	Cryptocurrency	In-store purchase	
Free trial?	60 days, credit card required	Money-back guarantee (30 days)	Money-back guarantee (30 days)	Money-back guarantee (30 days)	Money-back guarantee (60 days)	
Key features						
Data limits	None	None	None	None	None	
Kill switch?	✓	✓	✓	✓	✓	
Split tunnelling	Android only	✓	✓	✓	✓	
Obfuscation	✓	✗	✓	✓	✗	
Port forwarding	✗	ExpressVPN routers only	✗	✗	✗	
RAMdisk servers	✗	✓	✓	✓	✗	
IPv6 leak?	✗	✗	✗	✗	✗	
Post-quantum safe tunnels	✗	✓	✓	✗	✗	
Exit nodes						
Main European countries inc UK	✓	✓	✓	✓	✓	
Australia, Brazil, Canada, Israel, Japan, Mexico, New Zealand, USA	✓	✓	✓	✓	✓	
Selected other countries	Latvia, Lithuania, Luxembourg, Malaysia, Ukraine, South Africa, South Korea, Taiwan, Venezuela	Albania, Algeria, Andorra, Argentina, Armenia, Azerbaijan, Bahamas, Bangladesh, Belarus, Bhutan, Bosnia & Herzegovina, Brunei Darussalam, Cambodia, Chile, Colombia, Costa Rica, Cyprus, Ecuador, Guatemala, Indonesia, Isle of Man... and many more	Albania, Latvia, Moldova, Singapore, UAE	Albania, Argentina, Bosnia & Herzegovina, Chile, Colombia, Costa Rica, Estonia, Georgia, Indonesia, Latvia, Lithuania, Luxembourg, Malaysia, Moldova, North Macedonia, Slovakia, Slovenia, South Korea, Spain, Taiwan, Thailand, Ukraine, UAE, Vietnam	Singapore, Turkey, Ukraine	
Number of territories	38	94	36	60	29	
Total number of servers ²	54	3,000+	760	5,657	Not stated	
Legal residence	Czech Republic	British Virgin Islands (parent company in UK)	Sweden	Panama	US/Canada	
Connectivity						
Supported protocols	OpenVPN, WireGuard, Mimic (proprietary obfuscation)	OpenVPN, Lightway	OpenVPN, WireGuard	OpenVPN, WireGuard, L2TP/IPSec, SOCKS Proxy	OpenVPN, IPSec/IKEv2	
Number of simultaneous devices	10	8	5	10	1/5/10	
Browser plugins						
Chrome	✓	✓	✗	✓	✗	
Edge	✗	✗	✗	✗	✗	
Firefox	✓	✓	✓	✓	✗	
Other	Avast Secure Browser	Safari	✗	✗	✗	
Platform support with apps						
Android	✓	✓	✓	✓	✓	
iOS	✓	✓	✓	✓	✓	
Linux	✗	✓ (command line)	✓	✓ (command line)	✗	
macOS	✓	✓	✓	✓	✓	
Windows	✓	✓	✓	✓	✓	
Other	✗	Kindle Fire, FireTV	✗	✗	✗	
Data policies						
Stated data retention policy	No identifying user data is logged	No identifying user data is logged	No identifying user data is logged	No identifying user data is logged	No identifying user data is logged	
No-logging proof?	✗	✓	✓	✓	✗	

¹Prices calculated using exchange rates in late June 2024. ² Active at time of review



		RECOMMENDED	LABS WINNER	RECOMMENDED	RECOMMENDED
	Private Internet Access	Proton VPN	Surfshark	Tunnelbear	Windscribe
	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★
	privateinternetaccess.com	protonvpn.com	surfshark.com	tunnelbear.com	windscribe.com
	£54 (£65 inc VAT) for 39 months	Free or \$108 (£86) for 2yrs	£46 (£55 inc VAT) for 27 months	Free or \$120 (£94) for 3yrs	Free or \$69 (£54) for 1yr
	£27 (£32 inc VAT)	\$60 (£47)	£32 (£38 inc VAT)	\$60 (£47)	\$69 (£54)
	£8 (£10 inc VAT)	Free or \$10 (£8)	£12 (£15 inc VAT)	\$10 (£8)	\$9 (£7)
	£27 (£32 inc VAT)	1yr \$72 (£57); 2yrs \$120 (£96)	£39 (£47 inc VAT)	\$60 (£47)	\$69 (£54)
	£1.67	£3.56	£2.03	£2.62	£4.46
	Cryptocurrency, gift cards	Cash, cryptocurrency	Cryptocurrency	✗	Cryptocurrency
	Money-back guarantee (30 days)	Free tier (limited endpoints), money-back guarantee (30 days)	Money-back guarantee (30 days)	Free tier	Free tier (limited endpoints)
	None	None	None	2GB per month/none	10GB per month/none
	✓	✓	✓	✓	✓
	✓	✓	✓	✓	✓
	✓	✓	✓	✓	✓
	✓	Windows only	✗	✗	✓
	✓	✗	✓	✗	✓
	✗	✗	✗	✗	✗
	✗	✗	✗	✗	✗
	✓	✓ (free: Netherlands)	✓	✓	✓ (free: 7 inc UK)
	✓	✓ (free: Japan, USA)	✓	✓	✓ (free: Canada, USA)
	Albania, Algeria, Bahamas, Bangladesh, Cambodia, Chile, China, Colombia, Costa Rica, Egypt, Estonia, Georgia, Hong Kong, India, Indonesia, Isle of Man, Kazakhstan, Latvia, Macau, Monaco, Mongolia, Nigeria, Panama, Philippines, Qatar, Saudi Arabia, South Africa, Sri Lanka, Turkey, Ukraine, UAE, Venezuela, Vietnam	Premium: Cambodia, Chile, Colombia, Costa Rica, Cyprus, Ecuador, Egypt, Estonia, Georgia, Hong Kong, India, Latvia, Lithuania, Luxembourg, Malaysia, Malta, Moldova, Myanmar, Nigeria, Peru, Philippines, Puerto Rico, Russia, Serbia, Singapore, Slovakia, Slovenia, South Africa, South Korea, Thailand, Turkey, Ukraine, UAE, Vietnam	Albania, Algeria, Andorra, Armenia, Azerbaijan, Bahamas, Bangladesh, Belize, Bhutan, Bolivia, Bosnia & Herzegovina, Brunei, Cambodia, Chile, Colombia, Costa Rica, Cyprus, Ecuador, Egypt, Estonia, Finland, Georgia, Ghana, Greenland, Hong Kong, Iceland, India, Indonesia, Isle of Man, Kazakhstan... and many more	Argentina, Bulgaria, Chile, Colombia, Cyprus, Indonesia, Kenya, Latvia, Lithuania, Malaysia, Moldova, New Zealand, Nigeria, Peru, Philippines, Slovenia, South Africa, South Korea	Free: Hong Kong, Turkey. Pro: Albania, Azerbaijan, Bosnia, Cambodia, Chile, Estonia, Georgia, Ghana, Hong Kong, India, Indonesia, Kenya, Latvia, Lithuania, Luxembourg, Malaysia, Moldova, New Zealand, Panama, Peru, Philippines, Russia, Serbia, Singapore, Slovakia, South Africa, South Korea, Taiwan, Thailand, Turkey, Ukraine, UAE, Vietnam
	83	3 / 67	100	47	10/68
	3,341	2,992	3,200	Not stated	100
	US (parent company in UK)	Switzerland	Netherlands	Canada (parent company in US)	Canada
	OpenVPN, WireGuard, L2TP/IPSec, SOCKS5 Proxy	OpenVPN, WireGuard, IKEv2/IPSec	WireGuard, OpenVPN, IKEv2/IPSec	WireGuard, OpenVPN, IPSec/IKEv2	OpenVPN, IKEv2/IPSec, SOCKS5, WireGuard
	Unlimited	1/10	Unlimited	Unlimited	1/ unlimited
	✓	✓	✓	✓	✓
	✗	✗	✗	✓	✓
	✓	✓	✓	✓	✓
	Opera	✗	✗	✗	✗
	✓	✓	✓	✓	✓
	✓	✓	✓	✓	✓
	✓	✓ (command line)	✓ (command line)	✗	✓
	✓	✓	✓	✓	✓
	✓	✓	✓	✓	✓
	✗	✗	✗	✗	Fire TV, Nvidia Shield
	No identifying user data is logged	Logs may be enabled under court order	No identifying user data is logged	No identifying user data is logged	No identifying user data is logged
	✗	✗	✗	✗	✗

Key considerations when choosing your perfect VPN

When you start using a VPN, you're trusting a third-party company to look after your data and your privacy – so make sure you're aware of all the factors

First, let's define what we mean by a VPN. A virtual private network is an encrypted connection from your device to a remote server. You may have encountered one in the workplace, allowing those working remotely to access an on-premises or cloud-based office network.

But we're looking at consumer VPN providers. These subscription-based services provide an encrypted tunnel for all your internet traffic and typically provide endpoint servers in scores of different locations, allowing you to virtually locate yourself in any of those places.

Privacy is a major selling point for VPN services. Data going to and from your device through an encrypted link to a remote server can't be inspected by your ISP or, typically, monitoring tools on a local network.

■ Region shifting

However, the most popular reason for using a VPN is to access region-locked entertainment content, such as the extended movie catalogue of US Netflix, national TV from other countries, or US newspapers that have blocked UK and EU readers rather than comply with our more stringent data protection laws.

Media licence holders are obviously unhappy about this and have pressurised streaming companies to ensure compliance. As a result, there's now an arms race between streaming services that are increasingly blocking IP ranges they think are likely to be used by VPN providers, and VPN services seeking to obtain residential IP addresses from blocks assigned to home users.



ABOVE Accessing region-locked content is a prime motivation for using a VPN

We were impressed by the number of VPN services that allowed us to watch international streaming services

Some VPN services, such as Mullvad and Avast SecureLine, don't prioritise region-shifting for streaming and don't advertise their services on that basis. Most major VPN providers, however, take efforts to give you access to region-locked content.

We were impressed by the number of VPN services that allowed us to watch international streaming services (see the results on p95). This is a snapshot in time, but most of the VPNs we've tested this month are committed to this arms race against geolocking. And VPN providers that focus on region-shifted streaming extensively acquire and

test appropriate IP address blocks to evade anti-VPN measures by the likes of Netflix, Amazon and the BBC.

■ Privacy rules

If you're primarily interested in a VPN for privacy, you should know exactly what you need privacy from.

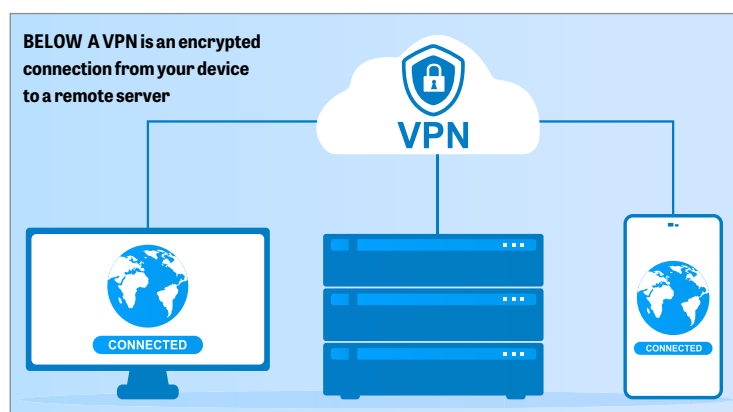
The archetypal example is a public, office or even home network on which

you'd like to either protect yourself from sniffing attacks that seek to capture data you pass back and forth (somewhat less of an issue than it once was, as HTTPS has become ubiquitous) or in order to evade content filtering. This can include national-state or ISP level filters, ranging from the great firewall of China to blocks designed to keep adult content out of the hands of anyone who can't – or doesn't want to – hand over ID to prove that they're over 18.

A VPN provider is essentially an alternative ISP. This is great if you don't trust your ISP not to either restrict your access to certain websites, apply content-based throttling or snoop on your activities, but you're now entrusting that same data to a random VPN provider.

Research the service you're going with, any features and restrictions that may apply, and any local laws that may affect its activities. Every single VPN provider we've tested promises to keep no identifying user logs, but many jurisdictions have laws that can be used to compel a VPN provider to collect or hand over what data they have.

The best services are up front about this and take measures to mitigate risk. These include RAMdisk servers, in which everything is stored in volatile





memory that's wiped on reboot or power down; allowing customers to pay anonymously using cash, gift cards or cryptocurrency; blocking endpoint servers in specific countries from activity such as torrenting, which comes with a legal obligation to keep logs; and headquartering themselves in countries with privacy-friendly laws – Panama, Switzerland and the British Virgin Islands are popular choices. It's worth noting that even privacy-friendly Switzerland is part of international law enforcement agreements.

Some VPN providers that claimed to keep no logs have handed logs over upon receiving a court order. Others, particularly those that primarily

ABOVE A VPN helps keep your data safe even on public Wi-Fi

Some VPN providers have been caught spying on users' app load-outs or collecting user data to sell to advertisers

advertise themselves on mobile app stores, have been caught spying on users' app load-outs or collecting user data to sell to advertisers. This group test does not include any VPN provider that we regard to be disreputable in this way.

■ Key features

We won't recommend or even review any VPN that lacks a kill switch feature. This will stop all network traffic to and from your PC

if the VPN drops. It's a vital way of ensuring that no data is accidentally sent via your standard internet connection. Note that this feature usually has to be manually enabled.

Split tunnelling allows you to exclude specific applications or IP ranges over a VPN connection and the rest via your usual connection. This is handy if you want to access other international and local streaming services or you want to access content that requires a local IP address.

The most common form of split tunnelling is a tickbox allowing you to access devices on your local network, but many VPNs, including ExpressVPN, NordVPN and Proton VPN, allow you to use whitelists and/or blacklists to include or exclude specific apps, URLs or IP ranges from your VPN connection.

■ Obfuscation

If you're using a VPN to work around a national firewall in a country that bans the use of VPNs, such as the UAE, Russia, Turkey, Belarus or China, then a connection mode that hides the very fact that you're using a VPN is essential. It's also handy on a corporate network that deploys VPN detection. Techniques include removing packet headers that may identify VPN traffic, using SSL encryption or otherwise disguising VPN traffic as standard HTTPS traffic.

A WORD OF WARNING!

Be careful about using a VPN permanently. There are times when hiding your location can work against you – such as when buying from UK stores online. Or when having a live chat with someone for support, and they think you're based in Norway (for example) rather than the UK.

How we test VPNs

Tests are carried out on a Windows 10 desktop virtual machine hosted on a server with a 10Gbits/sec symmetric fibre link. We connect to endpoints in the UK, Netherlands and USA. These download content from reference servers located in London, Amsterdam and New York.

We do this via HTTP using curl at the Windows command line. All paid-for VPN services, which are unlimited, download around 600MB of data, to allow us to observe variations in download speeds over time. We also used this test for the free VPN services, as all of them provide sufficiently large bandwidth allowances to permit it.

At the time of testing, our virtual machine's reference connection speeds were a little slower than usual at 98Mbits/sec to our UK target, 122Mbits/sec to the Netherlands and 51Mbits/sec to the USA. These reflect internet conditions at the time of testing and were again reflected by the performance of most of the VPNs.

Some VPNs were able to significantly improve on our un-VPN'd speeds, illustrating another potential advantage of using a VPN: faster connection speeds by using the VPN

provider's efficient international network routing infrastructure.

We saw speeds of up to 308Mbits/sec (via Proton VPN's Netherlands endpoint). Those on slower internet connections can also benefit from improved download speeds, particularly to remote locations such as the US.

The disadvantage of using download speed as a proxy for overall performance is that it only provides a snapshot of a single metric at a point in time. We re-test unusually fast or slow results. We also rely on several years' worth of historic test data for a variety of popular VPN services to provide a long-term performance reference. All data is publicly available at vpndatatracker.com for transparency purposes. We take historic performance into account in our overall ratings.

We also test video-streaming performance, as many people want a VPN to watch overseas video content and many more want to be able to watch local content unimpeded while connected to a VPN. For this group, we tested videos exclusively available via iPlayer in the UK, Netflix in the US and Amazon Prime Video in the US.

As shown by our results, Netflix in particular has continued cracking down on VPN users, though its recent anti-account sharing measures didn't impact our ability to access its US services. When Netflix detects that a VPN is in use, it will typically still show your videos, but only provide access to content that's local to the user's home. In some cases, Netflix US won't allow overseas accounts to log in when connected to a VPN, but if they're already logged in it will provide access to US-exclusive content without a fuss.

BBC iPlayer blocks access and sets a cookie to prevent further access from that browser even when you've disconnected from the VPN, so you'll have to clear this between failed attempts.

Amazon Prime Video claims to restrict access to its US catalogue to even overseas Prime Video subscribers when they visit the US. However, we found that we were able to freely access films that were unavailable or only available to rent or buy in Europe from the US Amazon video portal with no difficulties at all. Note that the US video portal has a different URL to the EU and UK Prime Video portal.



EXPRESSVPN

A great service and feature set, but it's expensive and its laundry list of controversies keeps growing

SCORE ★★★★★

BEST DEAL 1yr \$100 (£79)

from expressvpn.com

RENEWAL PRICE 1yr \$100 (£79)

ExpressVPN always performs astonishingly well in tests, but when choosing a VPN there are other factors you may wish to consider. And the challenge for ExpressVPN is that it has recently been dogged by dubious corporate decisions and, earlier this year, the revelation of a long-standing bug that exposed the split-tunnelled DNS requests of some Windows users.

One controversy came from the company's support of now-departed board member Daniel Gericke, found to have worked as a mercenary spy exposing journalists and activists who criticised the government of the UAE. This all happened ahead of a conveniently timed acquisition by Kape Technologies, so it's up to you to decide if the corporate changes make any difference to your decision.

The bad press continued earlier this year with the discovery that, between May 2022 and February 2024, a small minority of Windows users who had enabled split tunnelling weren't getting the level of protection they were promised for traffic they chose to route outside the VPN. This requires some explanation. Like most VPN services, ExpressVPN has a split-tunnelling feature in its client so, for example, you can route a few apps via your local internet connection while everything else is still VPN'd to another geographic region. In ExpressVPN's implementation, even traffic that's excluded from the VPN tunnel is supposed to use the company's own DNS servers, so that your ISP doesn't have a record of what sites you're looking at.

That wasn't happening in all cases, however, and although ExpressVPN says that it affected just 1% of Windows users, the fact that this bug existed for almost two years indicates that both the internal and third-party security audits that the company puts its software and infrastructure through weren't as good as they might have been.

The bug appears to have been an extreme edge case that may only have affected users with multiple different VPN clients installed. Once reported, ExpressVPN promptly issued an update to remove the split tunnelling feature from its Windows apps, and two months later put out new versions of its VPN clients for the platform, publishing details of its fault-finding and remediation process. This was admirably well communicated, something that isn't always the case in the VPN industry.

Enough controversy: let's talk speed. ExpressVPN always lives up to its name, and this month is no exception. Although many other services appeared to be affected by adverse routing conditions during our testing period, ExpressVPN's infrastructure performed well.

In our throughput tests, we saw speeds of 204Mbps/sec from the UK, 264Mbps/sec from the Netherlands and, most impressively, 190Mbps/sec from the US, almost four times our un-VPN'd speed. This puts it alongside Surfshark, Proton VPN and NordVPN as one of the fastest services you can choose for your VPN needs. It's great for region shifting, too, allowing us to watch content from BBC iPlayer, Netflix US and Amazon US without being detected and blocked as a VPN user.

Graphical clients are available for Windows, macOS, Android and iOS, plus a Chrome extension and a command-line client for Linux. As well as distributing the Android app on Google Play, ExpressVPN makes its Android app available to

ABOVE ExpressVPN is one of the best for region shifting

Although other services appeared to be affected by adverse routing conditions in our testing, ExpressVPN performed well

BELOW We saw excellent speeds when connected to ExpressVPN

download directly from its website, so users with de-Google'd phones won't have to compromise their security.

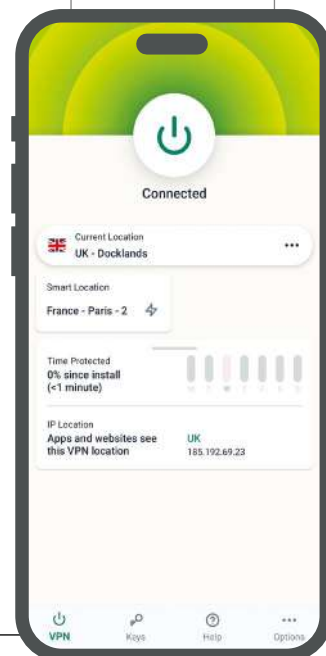
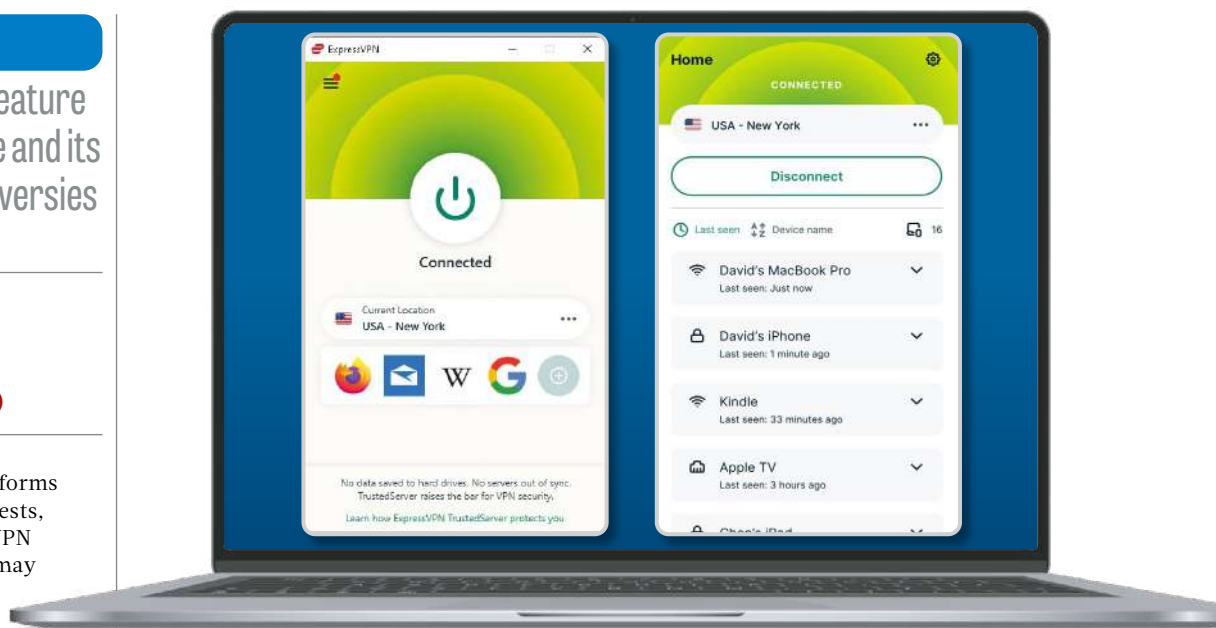
ExpressVPN supports OpenVPN and its own proprietary Lightway protocol. There are plenty of configurable features, including the aforementioned split tunnelling (now

working properly), a kill switch and the ability to block ads, trackers, known malicious sites and adult content.

ExpressVPN has, like many of its rivals, started bolting extra, non-VPN features on to its service. Here, it's a password manager, ExpressVPN Keys. It's only available as a standalone extension for Chrome, or built into the ExpressVPN Android and iOS apps. While the password manager appears to be fairly well implemented, we strongly recommend that you don't tie a long-term need such as

password management to other subscriptions, whether that's a VPN, an antivirus suite or anything else. If you don't want to pay, Bitwarden is free.

ExpressVPN is among the more expensive services around, although you get a chunky discount the first time you subscribe. An initial subscription costs £45 per year, £85 for two years, or £112 for three (including VAT). However, all subscriptions renew at £80 per year – that's almost double the initial one-year subscription fee, and could come as an unpleasant sting on your card bill. The good news: you can connect up to eight devices simultaneously, which should cover most household uses.



NORDVPN

Frequent winner NordVPN does it again thanks to a fast service that's effective for region-shifted streaming

SCORE ★★★★★

BEST DEAL £78 (£94 inc VAT) for 27 months from nordvpn.com
RENEWAL PRICE £66 (£79 inc VAT)

Although it has been pipped to the Labs Winner award this month by its stablemate, Surfshark, NordVPN is one of the best all-purpose consumer VPN services around.

Clients are available for Windows, macOS, Android and iOS, with a command-line Linux client and direct downloads of Android APKs for use on de-Google smartphones. And it doesn't stop there, with browser plugins for Chrome, Firefox and Edge, plus instructions for connecting numerous other devices.

NordVPN has really gone for it when it comes to adding extra features to its service, as reflected by the main interface of the Windows client. This shows the status of your VPN, Threat Protection and File Sharing modules, as you can see in the screenshot above. The core VPN interface remains intact on its own tab, and it can be configured via the settings menu, where options include the obligatory kill switch, split tunnelling, your choice of WireGuard-based NordLynx or OpenVPN protocols, and various options to manage network behaviour – such as allowing RDP connections or remaining hidden from a LAN.

There's also a whole suite of anti-malware tools in the standard client that are active when you're connected to NordVPN. They don't clash with or replace Windows Defender, or any other antivirus suite you might have installed, although it's not an on-demand scanner in the style of Malwarebytes. Instead, by default the web protection module blocks or warns you about known malicious and phishing sites, as well as blocking ads and trackers, and stripping tracking URLs. You can also enable DNS filtering – only when connected to the VPN – which blocks ads and malware before traffic is sent to you.

File protection is an on-download malware scanner that says it will scan anything you download, with the

option – which is off by default – of sending suspicious files back for automated analysis. However, it appears to scan only EXE files, ignoring potential threats in the form of ZIP files. Then again, the in-browser protection against known malicious sites picked up at least one of the samples in our tests.

Perhaps more interesting is NordVPN's Meshnet and file-transfer features, which allow you to securely connect or send files between different computers that are connected to your NordVPN account (or which another NordVPN user has invited you to access). This is something of a throwback to private VPNs, allowing you to game together as if on a LAN, or simply access files on your home network while you're out. The latter feature assumes you've left your PC switched on and connected to NordVPN, mind you.

This is a really cool feature, especially given that NordVPN's Linux command-line app allows you to add headless servers to your Meshnet. The invitation and approval system is smooth and feels reasonably secure. For anyone who wants more than a standard consumer VPN has to offer, there's a lot to like here.

These features all come with a Standard NordVPN account. Nord doesn't list VAT until you get to the payment page, but pricing works out at about £12.50 for monthly renewals or a standard annual rate of £79 per year. However, first-time subscribers will pay £65 for one year, and get an extra three months free. Or you can buy a two-year sub

ABOVE The interface clearly displays the main modules' status



For anyone who wants more than a standard consumer VPN has to offer, there's a lot to like here

BELOW NordVPN's speeds weren't as rapid as they have been in the past



with three months extra free for £94 (all prices including VAT). That gives a competitive monthly price of £3.40 if you're willing to commit for 27 months. However, both of those subs renew at £79. It's not a huge price hike, but it could be an unexpected one if you leave billing auto-renewal switched on.

There are also more expensive tiers – NordVPN Plus bundles in a NordPass Premium subscription and more sophisticated Threat Protection Pro

anti-malware tools, and the NordVPN Complete tier adds an extra 1TB of secure cloud storage on top of that. However, both of these are beyond the scope of this review. At the time of writing, Nord is also

throwing in data vouchers for its Saily eSIM service, their value depending on the subscription tier.

NordVPN provides a great service, but the range of extra features and alternative subscription tiers is frankly confusing. At least the core product is reliable, however.

NordVPN didn't perform as well as usual this month, particularly via its UK endpoint, but it's still no slouch. We got throughput of 95Mbps/sec via the UK, 173Mbps/sec via the Netherlands, and 223Mbps/sec via the US. Although we couldn't improve on the UK result during the test window, it's definitely an anomaly – two previous tests within the past 12 months have seen NordVPN's UK endpoint produce speeds of well over 200Mbps/sec. Despite its wobbles, NordVPN remains a brilliant choice.



PROTON VPN

A long-term favourite and you won't have any regrets if you subscribe, but Surfshark pips it for now

SCORE ★★★★★

BEST DEAL Free or \$108 (£86)

for 2yrs from protonvpn.com

RENEWAL PRICE 1yr \$72 (£57);

2yrs \$120 (£96)

Proton VPN is famously privacy-conscious, with fantastic speeds and streaming performance, as well as well-designed desktop and mobile apps.

Proton Technologies has recently announced that it's transitioning to become a non-profit foundation under Swiss law (tinyurl.com/36oproton), free of shareholders and in line with its long-term goals of existing to promote privacy technologies for the public good. However, the customer-facing business will continue to be the responsibility of Proton AG, the commercial side, so in practice next to nothing will change for its users.

Proton takes privacy seriously, whether applied to its customers or as a global right. For example, the company provides free VPN access to users in areas where access to information is restricted, currently including Russia and Iran. Although Proton is privacy-focused, it's still subject to the law, and we've seen its Proton Mail email service targeted by recent Interpol and Europol warrants that have been characterised as frivolous, but which saw the company compelled to hand over metadata that led to the identification and arrest of its users. Proton VPN doesn't keep any logs so, in principle, there should be nothing to hand over in case of a warrant. The company maintains a tally of legal requests received (and denied) by Proton VPN.

Clients are available for Windows, a couple of different Linux distributions, macOS, Android and iOS. The Android version can be downloaded from Proton's own GitHub repository (github.com/ProtonVPN) or from F-Droid, for the benefit of anyone who's running a de-Google mobile device. There are also extensions available for browsers based on Firefox and Chromium.

Both desktop and mobile clients look great, making it easy to find endpoint locations and enable the kill switch, port forwarding, and

malware, ad and tracker blocking features. You can also enable Secure Core, which helps to ensure the security of your data by routing it through Proton's infrastructure. It does this in a way designed to evade efforts to trace its route back to you by sending via multiple endpoint servers that Proton physically controls in privacy-friendly countries. Proton's Alternative Routing feature further helps the service evade any attempts to block it.

Additional settings allow you to set up split tunnelling, route around potential blocks of Proton's known IP addresses, configure the client's behaviour and appearance, and switch between protocols. On the Windows desktop app, you can choose between WireGuard and OpenVPN over either UDP or TCP. Proton also has as an obfuscated protocol to help avoid detection of the fact that you're using a VPN by national firewalls. However, this is only available on Android, iOS and macOS for the moment.

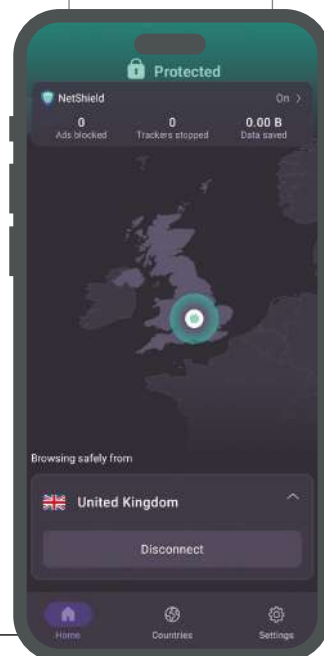
Apart from the free tier, Proton VPN will cost either £8 inc VAT per month, £48 for your first year (renewing at £57) or £86 for two years, renewing at £96 (all those prices are subject to exchange rate fluctuations). You basically get about £10 off the price as a one-off discount when you first subscribe. The price hike isn't bad, although we prefer the clarity of pricing without fee increases on renewal. Either way, it's reasonably priced. Users on a budget should consider Mullvad's fixed-rate one-month subscriptions that you can cancel whenever you like.

ABOVE Proton VPN puts privacy front and centre of its offering



The company provides free VPN access to users in areas where access to information is restricted, including Russia and Iran

BELOW The mobile app looks just as good as the desktop client



Compared to recent years, we saw unusually slow results from Proton VPN in this month's test – this was in common with most of the services we tested, suggesting an underlying issue somewhere along the routes between us and our usual test servers. On the other hand, "slower than usual" for Proton VPN is still several times faster than some other services.

We ran the same tests on both our free and paid-for accounts, although

because the only free servers are in the USA, Netherlands and Japan, we tested UK connection speeds from the Netherlands. Using a free account, we got speeds of 146Mbps/sec from the UK,

270Mbps/sec from the Netherlands and 107Mbps/sec from the US. Our paid account logged 121Mbps/sec from the UK, a blazing 308Mbps/sec from the Netherlands and 76Mbps/sec from the US. This mostly reveals exactly how high the margin of error is in VPN speed testing. That's where our historic test data comes in.

Over the last year, Proton VPN has consistently achieved the highest speeds in every individual test period, ranging from 125Mbps/sec to over 300Mbps/sec. If you're after speed, this is definitely one of the services to consider.

Proton VPN is also great for region shifting, allowing us to effortlessly watch region-locked programmes from iPlayer, Amazon and Netflix when connected to appropriate geographic endpoints.

All of which means this is a strong choice overall, and a great alternative to Surfshark.

SURFSHARK

Surfshark offers an excellent combination of privacy, speed and smooth region shifting

SCORE ★★★★★

BEST DEAL £46 (£55 inc VAT)
for 27 months from surfshark.com
RENEWAL PRICE £39 (£47 inc VAT)

Surfshark is reliably among the fastest VPN services we test, and it goes out of its way to ensure that international streaming services work. It has a credible track record for privacy, with regular third-party audits of its no-logging policy and RAMdisk servers so there's no chance of stray data being left on a disk.

However, Surfshark's pricing is more convoluted than we'd like. Don't subscribe monthly, because it costs £15 inc VAT per month, but its first-time subscriber one- and two-year offers are worth your time. You'll pay £37 for your initial one-year sub, and get a bonus three months added to your subscription. A two-year sub is even better value at £55, plus three months free. Both of these renew at Surfshark's standard price of £47 per year. Like sibling company NordVPN, Surfshark only calculates VAT at checkout, so its advertised prices are a little lower than what you'll actually pay.

There's no free tier or trial, except for a seven-day option that requires you to pay via your mobile app store, but there is a 30-day money back guarantee, and we were pleased to note that the company finally allows you to cancel recurring subscriptions without contacting a member of staff via email or live chat. You can pay using cryptocurrency if this is something you feel would aid your privacy, although we'd like to see a cash payment option in the style of Mullvad and Proton VPN.

If you want extra anti-malware features you can also get the VPN as part of the Surfshark One deal. This bundles Surfshark's interesting but still largely untested antivirus suite with a paid-for private search engine, and Surfshark One+, which adds a data broker and people search site removal service for your personal information. Naturally, these are beyond the scope of this group test.

Surfshark is headquartered in the Netherlands, having previously been

legally based in the British Virgin Islands. If a VPN firm doesn't actually keep logs then there's little that a European warrant could obtain from them, but those who would rather avoid companies based in countries that are in major intelligence-sharing networks should be aware of Surfshark's 2021 move. The company also published a warrant canary to indicate that it has not been subject to any gag orders.

Surfshark has dedicated clients for Windows, Linux, macOS, iOS and Android, with the latter being available as an APK for direct download as well as from the Google Play Store. There are detailed manual configuration instructions for TVs, computers and routers, and you can choose between WireGuard, OpenVPN or IKEv2 profiles, depending on what your devices support. Browser extensions are also available for Firefox, Edge and Chrome.

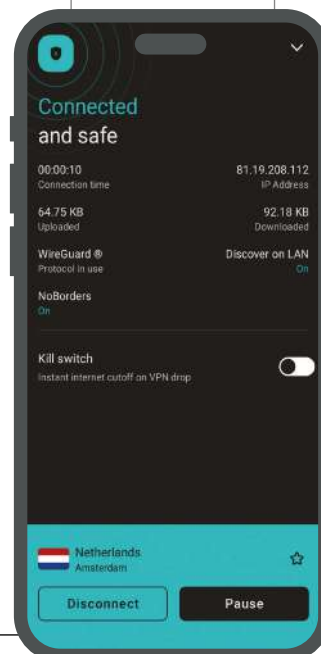
Surfshark's Windows client is reasonably attractive and suitably information packed. It's easy to select, connect and disconnect from endpoints. Although it makes sense to only ship a single client, we're not thrilled by the placeholder pages for modules that are only available to Surfshark One subscribers. The settings pages contain your key VPN options, including the kill switch – disabled by default – ad and tracker blocking, a pull-down that allows you to manually lock the client to a single VPN protocol of your choosing, the "Bypasser" for split tunnelling and a switch to make you invisible to devices on your local network.

ABOVE Surfshark is the one to choose if speed is your priority



Surfshark's blistering performance in our speed tests puts it ahead of its rivals this time around

BELOW Mobile and Windows clients are attractive and detailed



If you want to obfuscate the fact that you're using a VPN, you'll have to switch your protocol to OpenVPN (over either TCP or UDP), which uses "Camouflage mode" by default. This is clearly stated on Surfshark's help pages, but isn't made explicitly clear within the client. All protocols by default use "No borders" mode, which attempts to conceal signs of your VPN use from national firewalls.

The top flight of VPN providers is incredibly competitive at the moment. On a month-to-month basis, you'd be hard pressed to choose between NordVPN, ExpressVPN, Surfshark and Proton VPN, as they're all fast, capable and take security seriously. However, Surfshark's blistering performance in our speed tests puts it ahead of its rivals this time around.

It performed especially well over our un-VPN'd reference results, clocking in at 156Mbps/sec via a UK endpoint, 238Mbps/sec from the Netherlands, and an astonishing 372Mbps/sec when downloading data from a US server via a US endpoint. It also allowed us to watch local content on BBC iPlayer, Netflix US and Amazon Prime US, even if we had to rotate our endpoint connection a couple of times in order to get a working Netflix connection.

Although we'd rather it didn't have a renewal fee that costs more than its initial subscription offer, that price isn't too steep, is reasonably clearly advertised and not enough to prevent us from making Surfshark our top choice VPN service.



TUNNELBEAR

Tunnelbear is a great free choice and a fine all-rounder, even if it's pipped to the winning post by Surfshark

SCORE ★★★★★

BEST DEAL Free or \$120 (£94)
for 3yrs from tunnelbear.com
RENEWAL PRICE \$60 (£47)

Based in Canada but owned by US consumer security firm McAfee, Tunnelbear is a stalwart of the VPN industry. It has a solid reputation, a long-standing no-logging policy and submits itself to regular third-party audits. It doesn't, however, maintain a warrant canary or transparency report, which will be a deal-breaker for some, particularly as Canada is hardly a privacy safe haven. But for most consumer VPN users, Tunnelbear's privacy measures will surely be sufficient.

Graphical clients are available for Windows, macOS, iOS and Android, with OpenVPN setup instructions for Ubuntu Linux, but no manual configuration instructions for other devices, including routers. That's unusual for a VPN of this calibre.

Browser extensions are available for Chrome, Firefox and Edge. If you run a de-Googled Android fork, you'll have to download Tunnelbear from a third-party APK mirror, unless you particularly want to build it from the source code in Tunnelbear's GitHub.

The fact that you can only use Tunnelbear through its limited range of official clients is a point against it for users with specialist requirements. It's only a small minority of potential VPN customers being cut out here, but in a sphere that targets the security-aware by definition, it feels like an oversight.

In its favour, though, Tunnelbear is one of an increasing number of major VPN providers that allows users to simultaneously connect a nominally unlimited number of devices to its network.

Tunnelbear's cross-platform clients have consistent interfaces that are pleasant to use and look at, with plenty of useful options. These include the all-important kill switch, to keep data from leaking if you drop off the VPN, split tunnelling, and GhostBear obfuscation to help hide the fact that you're using a VPN at all (to hide you from national level firewalls). You

can choose between the OpenVPN, IKEv2 and WireGuard protocols.

We recommend Tunnelbear's free tier every time we review it, and we're about to do so again. Unlike most free VPN tiers, Tunnelbear gives you access to exactly the same range of endpoints that paying customers get, giving you an unparalleled ability to access region-locked websites. However, you only get 2GB of bandwidth every month to do that with, which doesn't necessarily last all that long on the modern web, particularly if you want to download anything or stream video.

Its paid-for subscriptions are reasonably priced and gratifyingly simple: you can subscribe for \$10 per month, \$60 per year or \$120 for three years. Tunnelbear occasionally runs short-term discount offers on special occasions, in which case your renewal will be billed at the standard annual rate.

Although we were a little disappointed by Tunnelbear's performance in this month's tests, it wasn't alone in suffering adverse network connections during the test period. VPN speed testing is a sadly inexact practice due to the sheer number of external factors that can affect it. Our tests from a paid-for Tunnelbear account saw speeds of 75Mbps/sec via the UK, 94Mbps/sec via the Netherlands and 69Mbps/sec via the US.

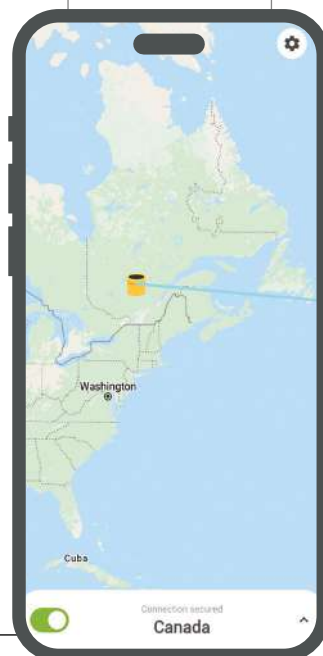
When we ran the same tests from a free account, we got throughput of 91Mbps/sec from the UK, 111Mbps/sec from the Netherlands and 27Mbps/sec from the US, which very much goes to

ABOVE Tunnelbear has one of the best free options around



Unlike most free VPN tiers, Tunnelbear gives you access to exactly the same range of endpoints that paying customers get

BELOW The excellent interface is consistent across all platforms



illustrate how much performance can vary between the same endpoint locations, on the same service, tested within minutes of each other.

Fortunately, we have historical test data to give us a better idea of what to expect from Tunnelbear in the long term, and it paints a rather better picture. Within the last year, we've seen speeds of up to 318Mbps/sec from the service, but – with only occasional exceptions – connections from Europe via a US endpoint tend towards the slow side when you compare them with the network performance of high-speed rivals Surfshark, ExpressVPN and NordVPN.

Tunnelbear hasn't always been a streaming-friendly service, but since it took a renewed interest in serving customers who wish to avoid regional geo-locks on media content, we've had few complaints about its ability to do so. We were able to watch region-restricted shows on iPlayer, US Netflix and US Amazon without being detected as VPN users.

Tunnelbear isn't the most exciting of VPN firms. It keeps itself up to date, but tends to adopt new technologies later than many of its competitors, such as the WireGuard protocol, which it introduced in 2023. However, a race to be the first with the hot new thing isn't always desirable in a security-oriented service, so we won't hold this against it.

While Surfshark takes top spot, this is a fine choice if its features match your needs – and it's particularly strong for those who prefer not to pay.

WINDSCRIBE

Windscribe takes the right approach to security and gives you an array of advanced features

SCORE ★★★★★

BEST DEAL Free or \$69 (£54)
for 1yr from windscribe.com
RENEWAL PRICE \$69 (£54)

Windscribe takes privacy seriously, both when it comes to features and to campaigning. It publishes a live transparency report that tallies up a list of every DMCA and government or law enforcement data request the company has ever received. It also works to provide free VPN access, in cooperation with NGOs, to journalists and entire regions where governments are attempting to suppress free communication.

Windscribe is, like rival NordVPN, prone to brash advertising – it even used a post in which it announced a security issue with one of its own endpoints to try to knock its rivals. Some of its sniping is genuinely useful, such as the company's effort to highlight a tendency towards potentially harmful conglomeration of the VPN industry. This includes the occasion when two big players bought several VPN providers and VPN review sites.

We tested both a paid-for Windscribe account and a free one. Performance is generally very similar, and that was the case this month as well. The one exception was the free US endpoint we used, which was a little over half the speed of a paid-for one, potentially due to contention; not all endpoint locations are available to free users.

We really appreciate the simple pricing choices that have been made here. You can get a free account, subscribe for a month at \$9 or pay \$69 for a year's subscription. There are no hidden renewal price hikes. If you have a paid subscription, you can simultaneously connect an unlimited number of devices – within reason. The company suggests that no-one will need to simultaneously connect 30 PCs or 25 phones.

Even though Windscribe isn't going to win any raw speed awards, its performance is mostly fine, and certainly adequate for casual internet use, despite the fact that it came in below our mean averages due to a

few exceptionally fast rivals. Note, however, that we've never seen Windscribe achieve conspicuously quick speeds when you're connecting from the UK or Europe to the USA – don't expect to get more than 50Mbps/sec even if you have a very fast connection. If you need a fast VPN for the US, better options include Surfshark and ExpressVPN.

Our paid subscription saw speeds of 91Mbps/sec from the UK, 111Mbps/sec from the Netherlands and 27Mbps/sec from the US. Our free account got 78Mbps/sec from the UK, 103Mbps/sec from the Netherlands and 15Mbps/sec from the USA.

Windscribe is great for region-shifted streaming, which works across all of its endpoints. We were able to watch iPlayer from a UK endpoint, as well as Netflix and Amazon's US services, and it's reliably good at this. It's one of the cheapest services to have a focus on geolock evasion for streaming content.

Windscribe's free tier is also one of the best around, as it gives you access to 11 of the same endpoint locations that paying customers get, and a generous 10GB monthly bandwidth cap. It's a useful middle ground between Proton VPN, with a free tier that provides unlimited data but only from three endpoint locations, and Tunnelbear, whose free tier lets you use all of its endpoints, but only gives you 2GB of bandwidth to play with every month.

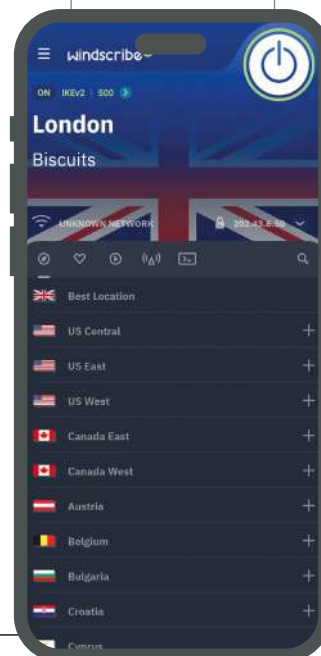
Clients are available for Windows, multiple Linux distributions, macOS, iOS and Android, plus browser extensions for Chrome, Firefox and Edge. There's

ABOVE Windscribe is secure, speedy and good value



Windscribe is great for streaming. It's one of the cheapest services to have a focus on geolock evasion for streaming content

BELOW The mobile app is just as fully featured as the desktop



also a manual configuration profile generator for multiple protocols that you might wish to deploy on other devices, such as routers. Windscribe distributes the Android client via the Google Play Store, F-Droid and its own website, making it easy to obtain for those who have de-Googled their devices for security reasons – a prime audience for VPN services.

The design and user experience between the mobile and desktop apps is consistent, as are most of your

settings, from allowing the device to connect to LAN traffic to experimental decoy traffic for additional obfuscation. Mobile devices can also spoof their GPS coordinates. Windscribe can also filter out

unwanted online content, from ads, malware and trackers – a common feature among modern VPN services – to clickbait, cryptocurrency sites, gambling, pornography and other standards of home or workplace filtering. You also get all the usual features, such as a kill switch (built into the Windscribe firewall) and split tunnelling so you can exempt specified apps or IP addresses from using the VPN.

Windscribe offers IKEv2, WireGuard, OpenVPN, Stealth and WStunnel protocols. You'll mostly be using WireGuard or OpenVPN, but it's nice to have this much choice, in case you need a specific configuration for any reason. The Stealth and WStunnel protocols are both variations on obfuscated OpenVPN.

This all adds up to a top-notch all-round service that's priced fairly.



Privacy browsers

If you only want a VPN to keep your web browsing away from prying eyes, then “privacy browsers” may be your best choice

As Google Chrome rolls out measures to prevent ad and tracker blockers such as uBlock Origin from working – Google is an advertising company, after all – more privacy-conscious internet users are turning to more secure browser choices. But how do they work and which should you choose? That’s what we aim to cover here.

■ VPN in your browser

As we cover in the reviews, many VPN providers also provide browser extensions, which may or may not require that you have the main app running in order to use them.

While some VPN extensions simply provide a browser-based control system for your desktop VPN, most will only send traffic from the browser itself via the VPN network. Technically, a “VPN” that only reroutes traffic from your browser is, in fact, a proxy; for it to be a true virtual private network, all data from your computer has to go through the tunnel. However, as long as you’re aware of the difference, there’s no reason to be particularly concerned about everyone’s accurate use of language. Just know that a browser-based “VPN” connection is very likely to only conceal the data sent from the browser that it’s active in, and not your entire PC.

They’re a great choice for people whose main interest in using a VPN is region-shifting for streaming media, as it makes it easy to watch overseas content without affecting anything else you’re doing on your computer. The same applies if you want to read overseas versions of a website.

■ Firefox-based choices



LibreWolf

Earlier this year, we’d have recommended Firefox if you cared about privacy and wished to use a mainstream browser, but Mozilla’s announcement that it’s to begin integrating adtech into Firefox means that we now recommend the privacy-focused LibreWolf browser as an alternative.

It ships with uBlock Origin and a choice of pre-configured privacy search engines, and leverages Firefox options such as enhanced tracking protection to block trackers and cookies, Do Not Track, an optional HTTPS-only mode, malicious site protection, and a fingerprinting-



resistant mode to spoof potentially identifying settings that websites can poll. You can even choose your own DNS resolver and install your favourite VPN’s proxy extension.



TorBrowser

A privacy-oriented, out-of-the-box secure spin on Firefox, as well as the easiest way to access Tor sites. While Tor is generally a good privacy solution, it’s no longer as bullet-proof as once thought, as exit nodes can be compromised, and it’s not always useful for mainstream websites. For example, content delivery networks (CDNs) such as Cloudflare often block traffic routed via Tor. However, all your traffic is sent through a Tor tunnel, and it costs nothing.



Mullvad browser

Available for Windows, Linux and macOS, Mullvad browser is a Firefox fork co-developed by the TorBrowser team and Mullvad VPN. It comes with the Mullvad browser extension already installed, but to use Mullvad’s endpoints for web proxying within the browser, you’ll also need to be running Mullvad’s standalone desktop app as well. It uses DuckDuckGo for search by default, and you can also use this browser with other VPN extensions if you’re not a Mullvad customer.

■ Chromium-based choices



Opera

Opera was the first major browser to integrate a VPN, and it’s free, too. However, since being bought by a consortium in 2016, things have gone downhill. Opera used to own SurfEasy, which powered its built-in VPN, but that was sold off to Symantec in 2016 after Opera was bought out. Meanwhile, Opera has flitted from trend to trend, flirting with the crypto bubble and then an AI browser. Opera does still operate a VPN – it’s not

entirely clear whether it’s white-label or the company’s own infrastructure – and had it independently audited by Cure53 in 2022. Fundamentally, it’s just another Chromium-based browser and you’d be better off adding a VPN extension to LibreWolf.



Avast Secure Browser

Avast’s offering has built-in anti-fingerprinting measures, ad-blocking and anti-phishing tools, and easy integration with Avast Antivirus’s Safe Banking. If you subscribe to Avast Secure Line VPN, you can use it as a proxy within the browser.

Avast is still tainted by a 2020 scandal in which its JumpShot subsidiary marketed user data to advertisers, so it may not be the first company to go to for a secure browser.



Brave

Brave browser, the project that resulted from founder Brendan Eich being drummed out of Mozilla for homophobia (he donated \$1,000 to a referendum that aimed to ban same-sex marriage), is another Chromium-based browser. It has its own search engine, and offers security options such as hiding social sign-in options from third-party sites, and blocks the kind of cross-site tracking that vanilla Chromium allows, but we’d still recommend using LibreWolf overall.

ABOVE LibreWolf is our current favourite privacy browser

A browser-based “VPN” connection is very likely to conceal only the data sent from the browser that it’s active in, not your entire PC

BELOW The Opera browser is not as privacy-focused as it used to be



AVAST SECURELINE VPN

Unless included in your AV subscription, there's no incentive to use SecureLine compared to faster rivals

SCORE ★★☆☆☆

BEST DEAL £93 (£112 inc VAT)

for 3yrs from avast.com

RENEWAL PRICE £67 (£80 inc VAT)

Unlike many antivirus-branded VPN services, Avast's SecureLine VPN has its own network of endpoints, rather than being a white-label service with a famous brand pasted onto it.

Avast's Windows client isn't much to look at. Its large window is dominated by an on/off switch, with other options hidden away in its settings menu. There's a kill switch, enabled by default to ensure that you don't leak data if your connection to SecureLine's VPN network accidentally drops. Avast automatically selects the most

effective protocol, but you can manually choose between WireGuard, OpenVPN and Avast's obfuscated Mimic protocol.

Only the Android app supports split tunnelling. The app is rather better looking than the Windows client, although it follows the same design ethos, and its settings menus are also easier to parse. You can pair mobile devices with your account either by installing the app and logging in or, more easily, by using the Pair Device feature in the desktop client's Settings menu. There are apps for iOS and macOS, but no Linux client and no support for manual VPN profiles. There are browser extensions for Firefox, Chrome, Opera and Edge.

ABOVE It's not much to look at, and Avast's performance isn't great, either



SecureLine is only available as a one-, two- or three-year subscription, priced at £40, £85 and £112 respectively (all inc VAT). All subs renew at £80 per year, which is a significant price hike to be aware of. You can only get a two months free trial if you provide your credit card details, which will be automatically billed after the trial period.

None of this would rule Avast out if its performance were better, but sadly its results in our tests were significantly worse than the other services we tested. It's important to note that

testing of this kind only represents a brief window in time, and that we don't have extensive historical performance data for Avast to compare against. However, we saw near unusable UK connection speeds averaging around 6.4Mbps/sec. Throughput from the Netherlands, at 90Mbps/sec, and USA, at 45Mbps/sec, was usable, if well below average.

One final note. Avast's JumpShot advertising subsidiary used customer data without permission, for which it was shut down in 2020. VPN users' data wasn't involved, but the controversy resurfaced this year in the wake of a US ruling against Avast by the FTC.

MULLVAD

The best choice if privacy is a priority and you don't like being tied into complicated long-term contracts

SCORE ★★★★★

BEST DEAL £5 (£4.22) per month from mullvad.net

RENEWAL PRICE £5 (£4.22) per month

Mullvad is an outstanding VPN, with a strong focus on privacy and transparency and an incredibly clear approach to pricing. However, as this is a specifically privacy-focused VPN, don't expect the same level of region-shifting reliability that you might see from services that are more focused on media and streaming. Although we were able to stream UK iPlayer and US Netflix content while connected to the service, Amazon detected that we were on a VPN and Mullvad itself makes no promises that you'll be able to evade geo-locked streaming restrictions.

Mullvad is intensely protective of its users' privacy, as illustrated when police came knocking on the Swedish company's door – only to go away with no user data, as none is retained. The company further commissions regular third-party security audits of its infrastructure, software and logging policies. Yet more reassurance comes from the fact that Mullvad uses RAMdisk servers across its infrastructure, which means that there are no disks from which data could be even hypothetically recovered.

Clients are available for Windows, Linux, macOS, Android and iOS. There's also a wealth of manual configuration profiles and mobile

ABOVE Mullvad is a great choice if privacy is your priority



installation options that avoid the Apple App Store and Google Play Store, making life easier for users of de-Google'd Android forks in particular.

Mullvad's performance in our speed tests has been more variable over extended periods than some of its rivals, and – as was the case with several of this month's tested services – was noticeably slower than expected in our recent tests. It's not bad, at 75Mbps/sec from the UK, 72Mbps/sec from the Netherlands and

56Mbps/sec from the US east coast, but it's a long way from the speeds of almost 200 to 400Mbps/sec that we've seen from Mullvad during other test windows. Although Mullvad's US connection speeds are generally on the slower side, you can safely expect to see fast speeds from European endpoints.

Fortunately, you don't have to commit to a long-term subscription to see if Mullvad is fast enough for you. One month's subscription costs £5, with no commitment. And that monthly price doesn't change no matter how many months you subscribe for, or whether you pay by card, cryptocurrency or by posting the company an envelope full of cash.



NORTON SECURE VPN

A perfectly strong product if it comes in a bundle, but we wouldn't pay the asking price as a standalone choice

SCORE ★★★★★

BEST DEAL First year, 10 devices, £58 (£70 inc VAT) from uk.norton.com

RENEWAL PRICE 10 devices, £67 (£80 inc VAT)

Most often bundled in security suites, Norton Secure VPN uses the VPN infrastructure of Norton subsidiary SurfEasy. This is a Canadian VPN firm, and it's actually significantly cheaper to subscribe to directly than Norton's VPN tiers.

Like most of Norton's services, Secure VPN is priced competitively for the first year, but then the renewal price goes up. In some scenarios, by a lot. Also, don't be lured in by its headline low cost of £1.67 per month, as that is for a single-device service at £20 including VAT for the first year. Five devices will cost you £30 and ten devices will set you back £70.

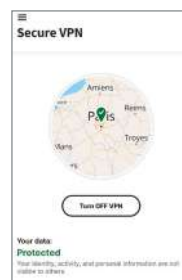


Also be aware that once you get onto year two of your subscription, renewals will be billed at £40 for one device, £60 for five and a steep £80 for ten. Most rivals offer support for unlimited numbers of devices.

Secure VPN's recent performance has been unremarkable, and this month's tests showed only a slight improvement. Connected via a UK endpoint, we got throughput speeds of 60Mbps/sec. From the Netherlands, we saw 99Mbps/sec. And US speeds picked up a little compared to the last time we checked, at 43Mbps/sec.

We were pleasantly surprised to find we were able to watch US Netflix and Amazon Prime content without

ABOVE Secure VPN is effective, but renewals can be expensive



any trouble, and that BBC iPlayer didn't complain about us watching while connected to the VPN.

Clients are available for Windows, macOS, Android and iOS, with no manual configuration options. We weren't impressed to find that Norton Secure VPN is listed on the Google Play Store as Norton VPN: Secure Wi-Fi Proxy, while another VPN product by an entirely different company was our top Play store result for "Secure VPN", creating a situation that's open to confusion. Norton does allow you to scan a QR code to link you to the correct Play Store page, but no official standalone APK is available.

Once downloaded, the Android app has other bad habits, such as demanding constant access to your device's location for its Wi-Fi Security options.

The Windows client is excessively simplified, with a large on/off button, an endpoint location selector and a handful of options in a settings menu, including a kill switch and controls for split tunnelling.

When it comes to performance, interface and pricing, Norton Secure VPN isn't worth the money. However, it's effective enough to be worth your time if it comes bundled with another Norton product.

PRIVATE INTERNET ACCESS

It's cheap, it works and it's not going to rip you off, but PIA is distinctly lacking in performance terms

SCORE ★★★★★

BEST DEAL £54 (£65 inc VAT)

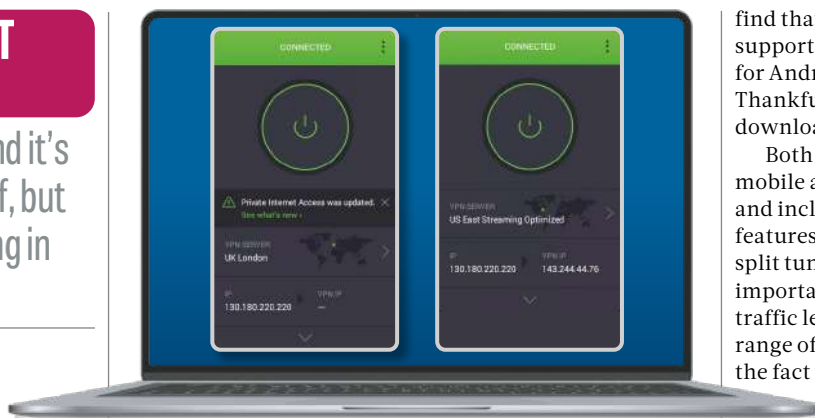
for 39 months from

privateinternetaccess.com

RENEWAL PRICE £27 (£32 inc VAT)

Private Internet Access is one of the longest-established VPN services, with a track record for privacy that appears to be holding even after its 2019 acquisition by Kape Technologies. However, although its pricing remains attractive, its performance is among the worst in this group, continuing a years-long trend.

PIA's performance from its fastest UK endpoint – reliably the one dedicated to video streaming – was 65Mbps/sec. To the Netherlands, we got 51Mbps/sec and, always



challenging, we saw just 18Mbps/sec from the US. That last transfer rate is a problem, as it isn't really sufficient for modern video-heavy websites to respond snappily.

PIA is pretty good at video streaming for a budget service, though, as long as you remember to use one of its dedicated streaming endpoints. Amazon Prime US caught us out, but Netflix and iPlayer didn't notice that we were on a VPN. PIA provides endpoints in a larger range of countries than most, which may be a consideration if you need to connect to sites via unusual locations.

Clients are available for Windows, Linux, macOS, Android and iOS, although we were disappointed to

ABOVE PIA's performance was among the worst in this month's tests



find that PIA doesn't officially support any alternative app stores for Android and its variants. Thankfully, it's easy enough to download it from APK mirrors.

Both the desktop clients and the mobile apps are pleasant to work with and include a range of important features, such as protocol selection, split tunnelling and that all-important kill switch to prevent traffic leakage. You'll also find a range of obfuscation settings to hide the fact that you're connected to a

VPN. If you don't need to VPN your entire device, browser plugins are also available for Firefox, Opera and Chrome.

Priced at £32 inc VAT per year or £65 per three years (plus an extra three months free), with no hidden renewal fees, PIA is a cheap and effective way of getting a VPN. In fact, along with Norton, it's the cheapest here at £1.67 per month if you commit to long enough. And that's clearly PIA's intention, as its monthly £10 tier compares poorly to Mullvad's fixed, no-commitment monthly deal.

PIA is neither fast nor perfect, but you can have a theoretically unlimited, and practically very large, number of simultaneous connections for any device you or your household is likely to need.

Best free VPN

If you only occasionally need to use a VPN, it makes a lot of sense to look carefully at the free offerings – as we’ve done here

Three of the VPNs on test include free tiers, and they’re all fine choices if you need a free VPN in a hurry. You’ll have to sign up for an account in each case, but you don’t have to provide any payment information or identifying data. You’ll find the performance data for each of these services’ free servers in our graphs overleaf.

The clients are exactly the same as the paid-for tiers of the same services, although platform-agnostic manual configuration options, for example using OpenVPN profiles, aren’t available for any of the free services we’ve looked at.

Best three free VPNs



Proton VPN

This is clearly the best free VPN service because you get unlimited data. Instead, Proton restricts which endpoints you can access to only three countries: the USA, the Netherlands and Japan. While this can do odd things to websites that use your IP address to localise their language and payment options, an unlimited free VPN whenever you need it is definitely worth the inconvenience.



Windscribe

With 11 endpoints for free users, you’ll probably be able to find one in a

country near you. The downside is that a steady diet of streaming media or disc image downloads will burn through your free 10GB quickly, but if you’re only using it to browse the web then that allocation will last you a good while.



Tunnelbear

Tunnelbear’s free tier is great, but 2GB of data simply doesn’t go that far on the modern web, even if you’re only accessing standard websites.

Other reputable free VPNs

While it’s generally understood that you don’t get something for nothing, a number of well-regarded VPN firms have free offerings, either as part of their efforts to make online privacy more accessible, or simply to get people to create an account, see how great their service is and – they hope – upgrade to a paid tier. Examples include PrivadoVPN (capped at 10GB per month), Trust.Zone (1GB per month) and Avira Phantom VPN (500MB per month).

We think we’ve found the best free VPNs around, but if you’re determined to find an alternative, make sure the company behind the



ABOVE Windscribe limits free users to 10GB of data a month

service is well established, with a track record of reviews in reputable publications.

What to avoid

Even if you don’t fancy the sound of any of the free VPNs we recommend, you definitely don’t want to pick one at random.

Free VPNs that you’ll see promoted on mobile app stores tend to have a

particularly poor track record. Some, such as Luna VPN for Android and iOS, are “snoopers” – that is, they’re used by companies such as Sensor Tower to poll what apps you have installed to add to the anonymised mobile app adoption data the company publishes and sells. It’s free to use, but you’re the product, not the customer.

Other free VPN services have simply been found to be badly secured, which entirely defeats the point of using a VPN in the first place. More worryingly, we regularly see free VPNs – both on mobile and targeting Windows users – being used as a delivery mechanism for malicious payloads. Examples in recent years have included iKHfaa VPN, MaskVPN, ShieldVPN and DewVPN, among many others.

Jargon buster

When it comes to choosing between VPNs, it pays to understand the lingo

■ **APK** stands for Android Package Kit and allows users to install Android apps independently of the Google Play Store.

■ **Kill switches** protect you when a VPN connection disconnects. Essentially, if the VPN connection drops, the kill switch activates and blocks your device’s internet access. This prevents you from accidentally sending data outside of the secure VPN tunnel.

■ **Port forwarding** allows inbound access to a PC through the VPN’s IP address. It can be used to host

networked games or access a home media service while you’re at work, and is also commonly used for torrent trackers.

■ **RAMdisk servers** store data (and the code necessary for the VPN to run) in RAM rather than SSDs or hard disks, so that if power is removed then all information is lost. It’s a handy extra layer of security for the privacy-conscious.

■ **Split tunnelling** allows you to divide your internet traffic. You can send some through an

encrypted VPN tunnel, while routing the rest through a separate tunnel on the open network. Split tunnelling is useful when you need to keep some of your traffic private, while still maintaining remote access to local network devices such as printers and NAS drives.

■ **VPN protocols** determine how data is routed and encrypted between the VPN server and your device. Some protocols emphasise speed, others prioritise security and privacy. In this guide, different protocols mentioned

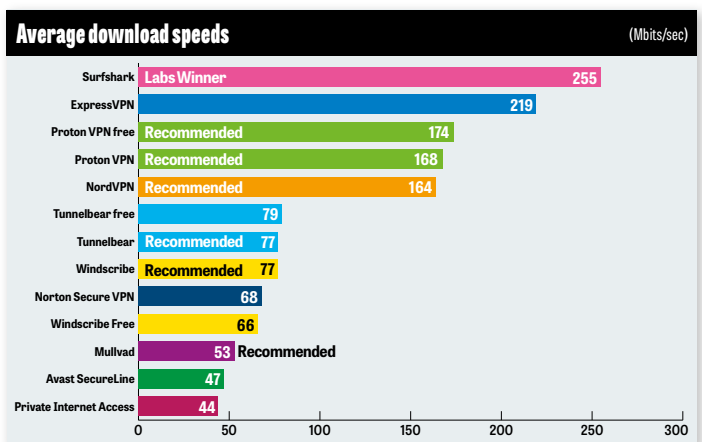
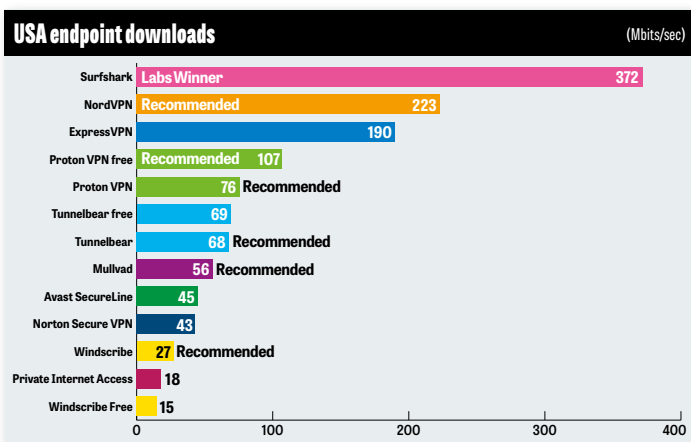
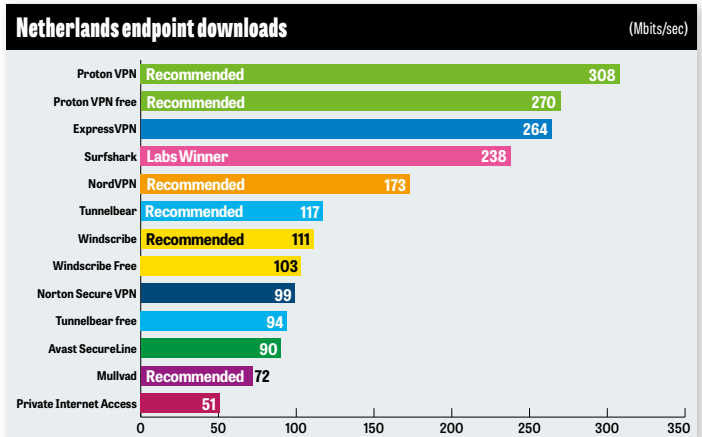
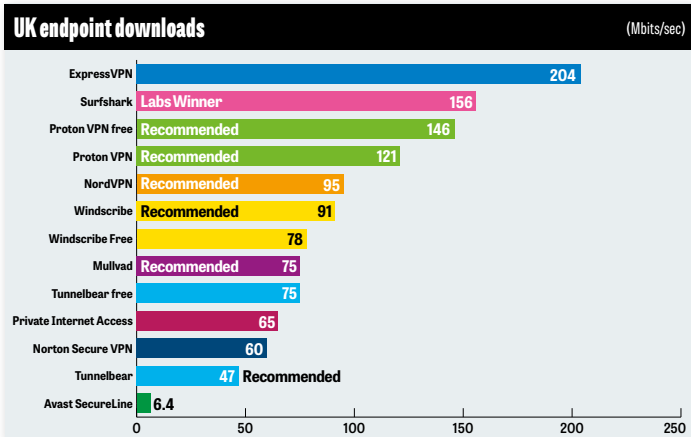
include OpenVPN, L2TP/IPSec, IKEv2 and WireGuard.

■ **VPN proxies**, on the other hand, are online services that hide your IP address by rerouting your internet traffic through a remote server.

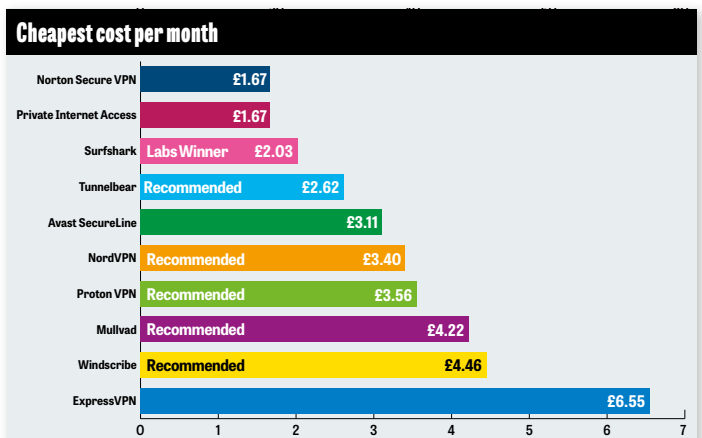
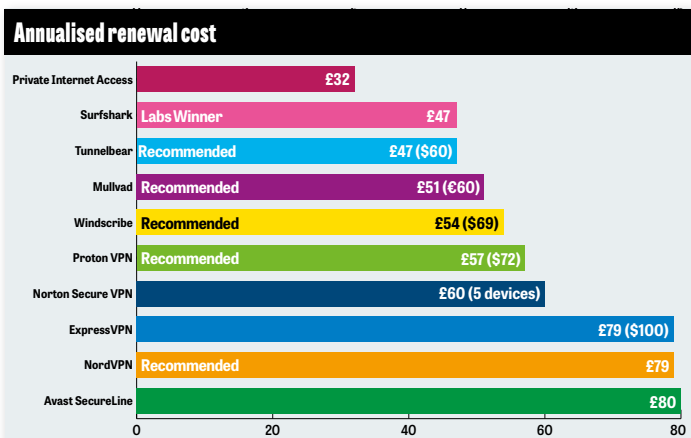
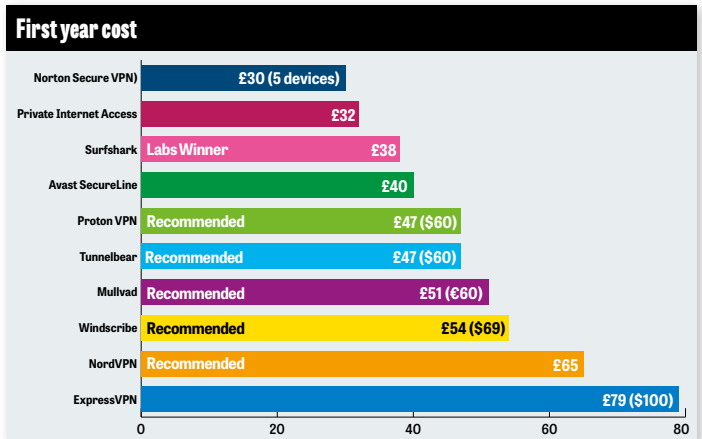
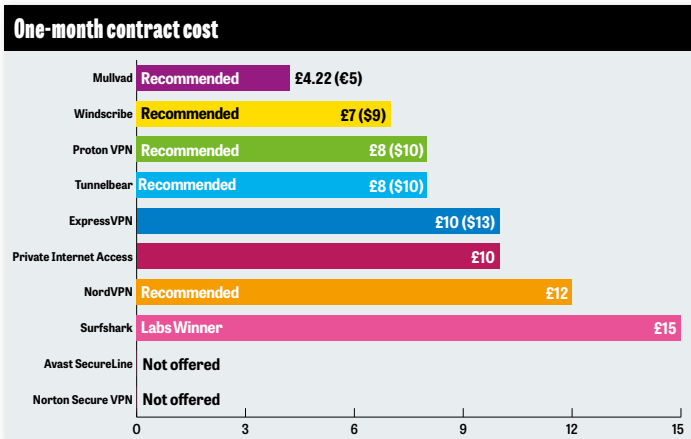
■ **A warrant canary** is a statement that declares that an organisation hasn’t taken certain actions or received certain requests for information from government or law enforcement authorities. If it’s removed, you know that the opposite is true. ➔



Speed tests



Cost comparison



View from the Labs

Read the subreddits or watch the sponsored influencer videos and you can get entirely the wrong idea about VPNs – so treat the gossip for what it is

The consumer VPN industry is young compared to the rest of the online security world, and lacks the relatively staid reputation of many of its counterparts. So we get bombastic advertising claims, wildly irrelevant YouTube influencer and gaming sponsorships, and officially endorsed subreddits where users are allowed to speculate about which of a company's rivals are secretly fronts for government agencies.

This isn't helped by some genuine controversies, from run-of-the-mill corporate acquisitions that have seen a single company own both multiple VPN firms and several publications that review them (Kape and J2 Global), to companies handing over logs they promised that they didn't keep in the first place (PureVPN, IPVanish under previous ownership).

This has led to a blame culture within the industry, with companies and their surprisingly partisan fans keen to make as much as possible of their rivals' errors or perceived faults. For example, a VPN firm can correctly announce a bug, communicate it to users and remediate the vulnerability, only to become the subject of tear-down blogs by rivals.

This most recently happened when a CNET journalist discovered that, under certain conditions, ExpressVPN's split



KG Orphanides
specialises in security
topics and provides a
regular testing
service of VPNs at
vpndatatracker.com
@kgorphanides

“Companies and their surprisingly partisan fans are keen to make as much as possible of their rivals' errors or perceived faults”

tunnel mode was failing to correctly route DNS queries outside the VPN via the company's DNS server and so was not concealing them from the user's ISP. ExpressVPN promptly announced the issue, removed the split-tunnelling feature from its Windows applications and, within two months, rolled out a correctly secured version of split tunnelling for Windows users.

Windscribe, always one of the more vociferous members of the industry, leapt on this opportunity to call out ExpressVPN's failings when the company's approach to reporting the incident was exemplary.

Windscribe's blog was right on many points, and shared my concerns about the usefulness of third-party audits if they fail to detect potential

edge case security issues, given that almost every vulnerability is an edge case. Windscribe is right when it says that no company should be above criticism or reproach, and I genuinely

appreciate its efforts to highlight dubious behaviour in the industry.

But it hasn't set an entirely consistent tone with its own behaviour. When Windscribe servers were seized by Ukrainian authorities in 2021, the company put its hands up

and admitted they hadn't been as well secured as they ought and contained unencrypted OpenVPN certificates and private keys on their hard disks.

This is the correct way to disclose, and Windscribe would go on to use more secure RAMdisk servers throughout its infrastructure. Unfortunately, Windscribe then followed up by listing every likely breach or certificate security failings that had or potentially could affect its major rivals. It wasn't a classy moment, and included some inaccurate assertions, notably against Perfect Privacy, whose servers were seized, but were running RAMdisks at the time, meaning no information could be extracted by police.

While it's certainly not required for companies to be polite to their rivals, particularly when calling out acknowledged bad behaviour, a degree of industry cooperation is useful. In the world of antivirus, this leads to valuable sharing of information about vulnerabilities and malware samples. For VPNs, it would be nice to see collaborative work towards new approaches to security, such as post-quantum encryption, new obfuscation tools, new protocols and a cooperative, open-source ethos that retains a sense of accountability, but dispenses with the back-biting. ●

Streaming video comparison



Provider	iPlayer UK	Netflix USA	Amazon Prime Video USA	Notes on each service
Avast SecureLine	No	Yes	No	Streaming endpoint but fails to play back content
ExpressVPN	Yes	Yes	Yes	Works on Edge but not on Firefox
Mullvad	Yes	Yes	No	
NordVPN	Yes	Yes	Yes	
Norton Secure VPN	Yes	Yes	Yes	
Private Internet Access	Yes	Yes	No	Choose streaming-specific endpoints per country
Proton VPN	Yes	Yes	Yes	Amazon took a couple of tries
Surfshark	Yes	Yes	Yes	Netflix took a couple of tries
Tunnelbear	Yes	Yes	Yes	
Windscribe	Yes	Yes	Yes	

The Network

Practical buying and strategic advice for IT managers and decision makers

Buyer's guide

Business protection 2024

A security appliance is an essential defence mechanism against cybercriminals and malware. **Dave Mitchell** explains what to look for and puts four options to the test

Small and medium businesses (SMBs) can't let their guard down when it comes to data security. The financial fallout from a data breach will be many times higher than the price of protection and, in the case of ransomware demands, could even drive them to extinction.

The 2023 Cyber Threat Analysis report by ISP Beaming identified an 8% increase in cyberattacks over 2022. It isn't looking any better in 2024 either, with Beaming saying it recorded a 5% increase in malicious online activity in the first three months of this year.

SMBs need to get serious about network security. Fortunately, it couldn't be easier: the latest unified threat management (UTM) security appliances are the perfect defenders. Along with a business-class firewall, many offer features such as malware protection, threat detection and intrusion prevention systems (IPS), as well as web and application security.

In this month's guide, we review security appliances from four well-established names: DrayTek, Firewalls, WatchGuard and Zyxel.

We've selected solutions suited to environments ranging from small and remote offices up to larger networks and test them in the lab to help you choose the best protection.

Super size me

Security appliances are ideal for businesses with limited on-site IT expertise as they integrate everything into one easily managed device. Deployment is simplified as all internet traffic passes through one point on the network perimeter, making it easy to apply security policies to all devices and users located behind it.

It's important to size your appliance correctly so it can handle current traffic loads but have headroom for more if your user base expands. All vendors quote performance figures in their datasheets with different security services enabled, but don't be swayed by the firewall throughput rates. These are always the highest as they're tested using lightweight UDP packets, which don't represent real-world usage. Services such as

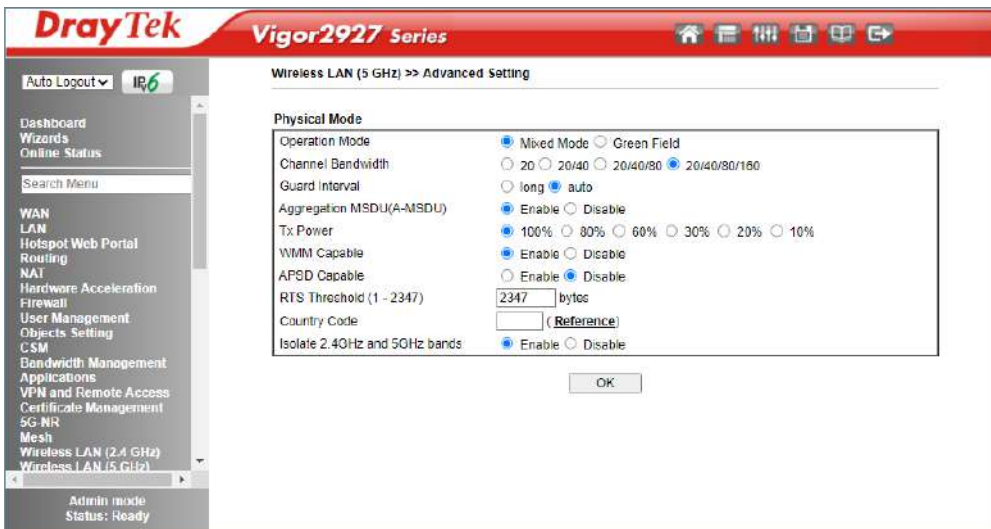
"If you're unsure which protection services you need, consider vendors that offer subscription-based licences"

anti-malware and IPS have much higher demands on appliance hardware so use these lower figures as a baseline when sizing the appliance for current and future demand.

If users do complain about poor internet responses, don't be tempted to disable any security services. Before buying, check that the prospective vendor offers an upgrade path as you may be able to trade in your appliance for a higher-performing model later on at a reduced cost.

BELOW DrayTek offers dual mobile SIM slots for redundant WAN connections





review offer URL category filters so you can stop users from visiting sites with undesirable content or those harbouring malware.

Application controls are another great feature. These use a database

containing thousands of signatures for managing access to common applications and categories such as file transfer software. With the vast majority of web traffic now encrypted, TLS (transport layer security) 1.3 inspection is another feature worth considering as this allows the appliance to decrypt and inspect HTTPS traffic at the network gateway.

Cloud connected

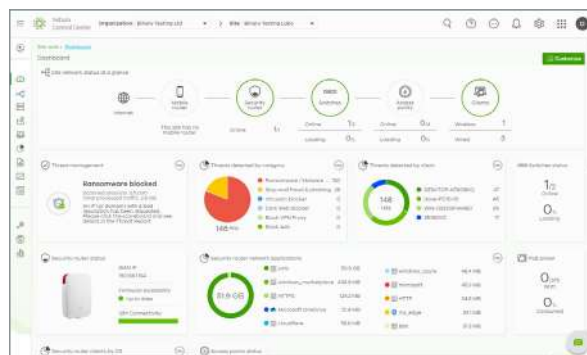
Businesses that want to extend protection to remote offices or home workers should consider vendors that offer cloud management. The best

ABOVE DrayTek's Vigor 2927Lax-5G includes integral Wi-Fi 6 services

LEFT WatchGuard's cloud portal global map shows where all web threats are coming from

"Businesses that want to extend protection to remote offices or home workers should consider vendors that offer cloud management"

BELOW Zyxel's cloud portal keeps you posted on all detected malware



ones provide free cloud portals so once you've registered the security appliance with your account, you can remotely monitor and configure it from anywhere over the internet.

Cloud management has many other benefits, too. After registration, the appliance's local web interface is disabled for added security. Essential firmware upgrades and signature updates are also easier to manage, with the cloud portal running these automatically to ensure you're always on the latest versions.

Zero-touch provisioning is another handy feature that can reduce the burden on support staff. After cloud registration and security policy assignment, the appliance can be sent to the remote site where all the end user has to do is plug it in and provide an internet connection.

Remote offices with patchy internet access may want to consider appliances offering WAN redundancy services. Many vendors have latched on to this and offer appliance models with integral LTE modems and mobile network SIM slots. One of the appliances on review has dual 5G SIM slots so you'd be having a really bad day to lose all internet access.

Wireless is the future

Many businesses are taking a

wireless-first approach to their networks, and the good news is a security appliance can protect them as well. You simply need to move your existing wireless access points

(APs) behind the appliance on its LAN side so it can inspect their traffic and enforce security policies.

Alternatively, look for appliances with a wireless gateway feature as these can centrally manage the vendor's own wireless APs. Smaller businesses that want all their network services under one roof should also consider appliances with an integrated wireless AP; we have one appliance on review that does both.

No business is too small to be of interest to cybercriminals, and if you want to stay safe in 2024 you need to invest in a security appliance. The products in this guide offer a wealth of valuable features at pocket-friendly prices, so turn the page to find out which one will keep your business and your staff protected.

Licence to protect

Security appliances offer an incredible range of features, but if you're unsure which protection services you need, consider vendors that offer subscription-based licences. That way, you can pick and choose from a security menu, upgrade to more features if needed and make savings by purchasing longer-term subscriptions.

All appliances come as standard with a business-class stateful packet inspection (SPI) firewall, and the base price should include support for a specific number of IPsec and SSL VPNs. Anti-malware is an important feature; this checks incoming traffic for malicious content and blocks it from getting into your network.

Sandboxing is an extension of anti-malware that protects against zero-day attacks. It blocks downloads of unknown files and examines them in a safe cloud environment to see if they contain any unpleasant surprises.

Web filtering can improve productivity as it allows you to decide which types of websites users are allowed to visit. All four appliances on



DrayTek Vigor 2927Lax-5G

This versatile small business security router is the only choice when internet failure is not an option

SCORE ★★★★★

PRICE £667 exc VAT from broadbandbuyer.com

DrayTek's Vigor 2927Lax-5G is an ideal appliance for small businesses that can't tolerate any internet downtime as it offers an incredible range of WAN redundancy features. Along with an integral 5G LTE modem sporting dual SIM slots for primary and backup mobile network connections, it can use two of its seven gigabit ports for WAN connections, the USB-A 2 port accepts a 4G modem and all can be linked together for load-balancing or failover purposes.

Redundancy features include the ability to deploy two routers in high availability mode. Sharing a virtual IP address, they can be set to hot-standby mode when sharing one internet connection or active-standby if each has its own link.

The router also delivers integrated Wi-Fi 6 services. Its AX3000-rated access point (AP) claims up to 574Mbps/sec on its 2.4GHz radio and 2,400Mbps/sec on the 5GHz one, plus it supports the Wi-Fi 6 high-performance 160MHz channels.

The Vigor 2927Lax-5G supports four SSIDs on each radio and can present a hotspot web portal for guest

access with a range of authentication methods. It runs DrayTek's Central AP Management service for automated provision of up to 20 DrayTek wireless APs and can even act as a root node in a meshed wireless network.

You're in luck if you want plenty of VPN services as the price includes support for 50 IPsec tunnels plus 25 SSL VPNs. The router can increase IPsec VPN performance by applying hardware acceleration.

Deployment is a breeze. The web console provides quick start wizards for configuring internet access using your choice of interfaces, creating VPNs and presenting secure wireless services. The firewall has a predefined security policy applied, which can be customised with rules and filters, and you can use them to enforce app controls and web content filtering.

It didn't take long to set up a mobile connection. We popped an EE 5G SIM in the top slot and enabled the 5G NR option in the web console's list of internet access connections. After a brief initialisation, it came online and we could view its properties from the 5G LTE status page.

ABOVE The Vigor 2927Lax-5G offers a wide range of redundancy options



"It doesn't provide anti-malware services, but this affordable security router offers an unbeatable set of WAN redundancy features"

Internet redundancy is configured by defining multiple WAN connections as active or backup links, where the latter is automatically brought online when the primary link fails or its traffic exceeds specific thresholds. Another option is to set all links as active and use load balancing to distribute traffic across them.

The router can also send and receive SMS messages. Alerts and status reports can be sent to specified mobile numbers, and password- or PIN-protected SMS messages used to remotely reboot it.

The hardware accelerator takes wired, wireless and 5G traffic passed to it from the firewall and content filters and bypasses the router's CPU. It makes a huge difference to wireless performance: disabling it saw file copies

between a gigabit-connected server and a Wi-Fi 7 Windows workstation average only 45MB/sec, which leapt to 112MB/sec with it enabled.

Businesses will find DrayTek's optional Cyren web content filter preferable to the free and somewhat basic German-hosted BPjM service. It offers 83 web categories that can be blocked or allowed using up to eight profiles. A 30-day trial can be activated from the web console, with a full subscription costing just £20 a year.

SMBs and remote offices that demand always-on internet access will love the Vigor 2927Lax-5G. It doesn't provide anti-malware services, but this affordable security router offers an unbeatable set of WAN redundancy features and adds extra value with its integral Wi-Fi 6 services.

SPECIFICATIONS

Fanless desktop unit • 5G LTE modem • 2x SIM slots • 7x gigabit (WAN, WAN2/LAN, 5x LAN) • USB-A 2 • 2.4/5GHz 11ax wireless • 2x WLAN/4x LTE aerials • external PSU • 241x165x44mm (WDH) • 670g • 2yr RTB warranty



BELOW The router includes built-in hardware acceleration

DrayTek Vigor 2927 Series

System Information

Model Name	Vigor2927Lax-5G	System Update	00:03:05
Router Name	Day 1st	Current Time	Thu May 30 20:24:15:37:14
Firmware Version	4.4.5	Build Date/Time	Jun 22 2024 11:19:55
		LAN MAC Address	14-45-BC-6D-BE-A8

IP4 LAN Information

Interface	IP Address	DHCP	IP Address	DHCP
LAN1	192.168.1.1/24	✓	LAN2	192.168.2.1/24
LAN3	192.168.5.1/24	✓	LAN4	192.168.4.1/24
LAN5	192.168.5.1/24	✓	LAN6	192.168.6.1/24
LAN7	192.168.7.1/24	✓	LAN8	192.168.8.1/24
DMZ PORT	192.168.164.1/24	✓	IP Reserved Subnet	192.168.8.1/24

IP4 Internet Access

Interface	Line Mode	IP Address	MAC Address	Up Time
WAN1	Ethernet / DHCP Client	192.168.2.1/24	14-45-BC-6D-BE-A0	00:02:45
WAN2	Ethernet / DHCP Client	14-45-BC-6D-BE-AA	00:00:00	
SG-MS	USB / DHCP Client	10.47.255.128	30-AD-C6-99-08-65	00:00:18
WAN3	USB 1	192.168.45.1/24	14-45-BC-6D-BE-4E	00:00:00

Interface

Interface	Line Mode	IP Address	MAC Address	Up Time
WAN1	Connected	2	WAN1 up WAN2 up SG-MS up WAN3 up	
LAN1	Connected	0	Port 1 Port 2 Port 3 Port 4 Port 5	
LAN2	Connected	0		
LAN3	Connected	0		
LAN4	Connected	1		
LAN5	Connected	0		
LAN6	Connected	0		
LAN7	Connected	0		
LAN8	Connected	0		
USB	Connected	0		

Security

Feature	Status	Remote Disables User / LAN to LAN
VPN	Connected	0
AntiVirus	Activated	1
DoS	Attack Detected	
RootCA		

System Resource

Resource	Usage
CPU Usage	0%

Firewalla Gold Plus

Packed with security features, this low-cost firewall is ideal for protecting networks and remote workers

SCORE ★★★★★

PRICE £461 exc VAT
from [firewalla.com](https://www.firewalla.com)

Targeting small businesses and home workers, the Firewalla Gold Plus is a multi-gigabit smart firewall with a price tag that will make them sit up and take notice. For a mere £461, it presents four 2.5GbE multi-gigabit ports for WAN and LAN connections and delivers an equally impressive range of network security measures.

Using its pocket-sized aluminium case as a heatsink, the Gold Plus is powered by an elderly but capable 2GHz quad-core Intel Celeron J4125 CPU, which is partnered with 4GB of DDR4 memory and a 32GB SSD for internal storage. Its primary function is to sit between your internet router and network, but it also supports a bridged mode if you have a separate modem and ISP router.

Installation is a piece of cake. We used Firewalla's iOS app to link an iPad to the appliance's USB security dongle for Bluetooth pairing, scanned the QR code on the firewall's base and waited a minute or so while it initialised. You don't need to do any more at this stage as the routine enables an inbound traffic inspection firewall policy and all the main security services, but a new feature in the app now allows you to immediately customise it to your requirements.

Select this option and a wizard requests your internet download and upload speeds and uses them to fine-tune its Smart Queue traffic prioritisation feature for Google Meet, Microsoft Teams, Webex and Zoom. You can set a data cap if you have one, allow the appliance to monitor internet speeds, latency and packet loss, and decide whether you want to enable strict modes for the Active Protect and Ad Block services.

The Smart Queue feature is very flexible. You can add more rules to the five default ones and control bandwidth usage by assigning one of three priorities, as well as upload and download limits. Targets can be apps, IP addresses or ranges, web domains or ports, and rules can be assigned to selected network clients. Firewalla can now apply these rules to specific geographical regions.

You can stop rogue devices sneaking onto your network by enabling the New Device Quarantine feature. When the appliance detects a new MAC address it places it in a quarantine group with LAN and WAN access blocked so you can decide what to do with it.

ABOVE The Firewalla Gold Plus is a multi-gigabit smart firewall



“Firewalla regularly updates the app with new features, and the latest version introduces a system vulnerability scan”

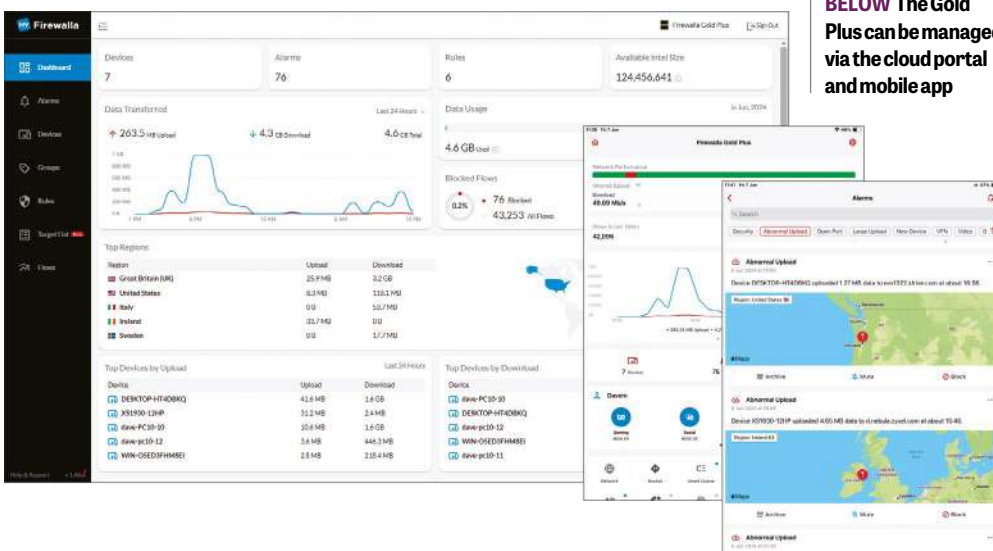
Firewalla regularly updates the app with new features, and the latest version introduces a system vulnerability scan. This applies a database of common username and password pairs to check all connected devices for security weaknesses. Select a device and the new dynamic control buttons show you the status of their access rules and provides an option to add them to the main dashboard.

It's common for people to have multiple devices, and these can be controlled by creating users and assigning them all to one account. Simply select a user from the app and you can see all their device activity, apply custom access rules and set time limits.

The appliance can be remotely managed and monitored from Firewalla's cloud-hosted MSP portal, with the free personal plan supporting one appliance. Adding the device is swift: you scan the portal's QR code, after which it presents just as much information as the mobile app, along with alert views and options to apply custom access rules.

The Firewalla Gold Plus is an affordable choice for protecting small business networks and value gets a boost as the price includes all security services, lifetime updates and online support. Easily managed and monitored from the mobile app and cloud portal, it delivers a fine set of security measures that belie its minuscule dimensions.

BELOW The Gold Plus can be managed via the cloud portal and mobile app



SPECIFICATIONS

Desktop fanless chassis • 2GHz quad-core Intel Celeron J4125 CPU • 4GB DDR4 RAM • 32GB SSD • 4 x 2.5GbE (WAN, 3 x LAN) • 2 x USB-A 3 • USB security dongle • HDMI • RJ45 console port • external PSU • Android and iOS mobile apps • 130 x 110 x 30mm (WDH) • 433g • 1yr hardware warranty



WatchGuard Firebox M390

An enterprise-class security appliance at an SMB price with an amazing set of protection measures

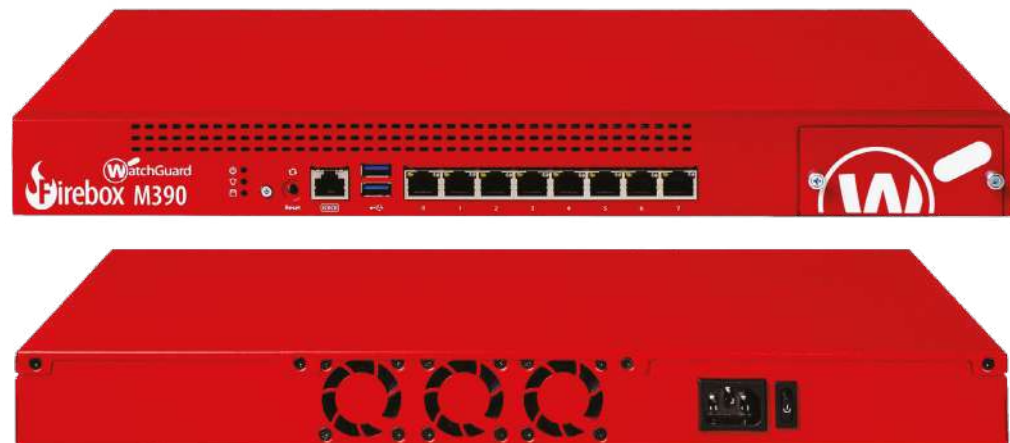
SCORE ★★★★★

PRICE Appliance with 1yr TSS subscription
£4,273 exc VAT from broadbandbuyer.com

WatchGuard's Firebox M390 shows that high-end security appliances don't always command a high price. Targeting busy SMBs with up to 250 users, this affordable 1U rack model boasts a top raw firewall throughput of 18Gbits/sec, dropping to a respectable 2.4Gbits/sec with all UTM security services enabled.

A simplified licensing scheme makes it easy to manage costs. We've shown the price of a Total Security Suite (TSS) subscription, which enables everything WatchGuard has to offer. This includes gateway antivirus, anti-spam, web content filtering, application controls, intrusion prevention services (IPS) and an advanced persistent threat (APT) blocker with cloud sandboxing.

You also get WatchGuard's reputation enabled defence (RED) cloud-based URL filtering, ThreatSync XDR for collection, correlation and automated responses to threat events, and DNSWatch to monitor client DNS requests and block access to known malicious domains. It has enough power to run the Cylance AI-based IntelligentAV malware scanning engine; the elderly dual-core Celeron in the M370 has been upgraded to an 8-core NXP LS2084A CPU.



ABOVE The Firebox M390 offers plenty of features for the price



"WatchGuard's WebBlocker service offers 166 URL categories that can be allowed, blocked or set to display a warning page"

through WAN port setup and applying new admin passwords, after which the appliance disables local management.

Cloud configuration is simple as the portal groups all security settings for the appliance in one page. From the content scanning section you activate antivirus scanning, APT blocking, IntelligentAV and anti-spam policies for incoming SMTP, IMAP or POP3 traffic.

The network blocking section covers botnet detection, IPS, port and site blocks and detection of Tor exit points. WatchGuard's WebBlocker service is accessed in the content filtering section and offers 166 URL categories that can be allowed,

blocked or set to display a warning page to users.

Each content filter action policy manages both web access and application controls. The latter presents nearly 1,300 predefined app and

protocol signatures, with Facebook and X activities getting the lion's share of the social networking category.

They're easy to apply; when creating firewalls rules, you simply choose the action policy you want to assign.

The portal's monitoring page provides a wealth of information on all activities. Graphs and charts are provided for live activity, traffic, detected malware and botnets, application usage, blocked websites, top clients and much more.

The Firebox M390 will appeal to SMBs with a large user base. It combines strong performance with an incredible range of security measures all at a competitive price. It's easy to deploy and WatchGuard's cloud portal delivers excellent remote management and monitoring features.

SPECIFICATIONS

1U rack appliance • 8-core NXP LS2084A CPU, 8GB RAM • 128GB M.2 SSD • 8 x gigabit (WAN, 7 x LAN • 2 x USB-A • RJ45 serial port • expansion module slot • warranty included in subscription

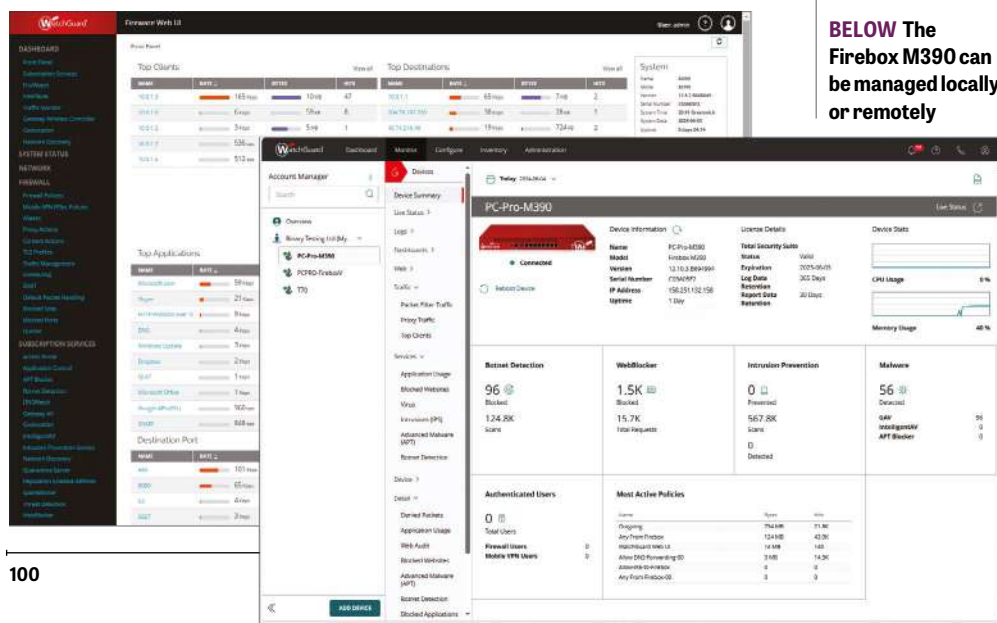
There's room to grow, as the front expansion bay accepts modules with gigabit, 10GbE or 2.5GbE multi-gigabit ports. Note that the PoE+ services on the multi-gig module will be disabled as the M390 doesn't support the required 54V power supply, which is only available on the M590 and M690 models.

The appliance is easy to deploy. Its web console wizard sorts out the LAN and WAN network interfaces and applies a base set of firewall policies that include blocking common undesirable web categories. We had already registered the appliance's serial number with our cloud support account so the wizard grabbed our TSS feature key and applied it.

The M390 can be managed in standalone mode, but businesses with multiple appliances will prefer WatchGuard's Cloud portal, which is included in both the Basic Security Suite (BSS) and TSS subscriptions. Two choices are available: you can keep local management and set the appliance to send its logs to the cloud for remote monitoring and reporting or move it all into the cloud.

Full cloud management is activated by allocating the appliance from your account inventory and enabling it from the local console. The portal steps

BELOW The Firebox M390 can be managed locally or remotely



Zyxel USG Lite 60AX

An entry-level security router with a fine set of subscription-free protection measures

SCORE ★★★★★

PRICE £142 exc VAT
from broadbandbuyer.com

SMBs and home offices seeking an affordable all-in-one security router will find Zyxel's USG Lite 60AX a worthy contender. This diminutive desktop unit teams up a Wi-Fi 6 access point (AP) with an integral multi-gigabit switch, and the price includes a lifetime subscription to Zyxel's Security Cloud.

This service includes a firewall, ransomware and malware prevention, VPN proxy, intrusion, dark web and ad blockers, application identification, GeoIP country restrictions, and mail fraud and phishing protection. The optional Elite Pack licence enables the Trellix-powered real-time threat intelligence and web category filtering services as well as a Nebula Pro Pack and costs £33 per year.

The router is designed to be desk-mounted, with the small and flimsy base stand rotated round to keep it upright. The switch has two 2.5GbE multi-gigabit ports for WAN and LAN connections and partners them with another four gigabit LAN ports, while the AX6000-rated AP claims speeds of 1,148Mbps/sec on the 2.4GHz radio and 4,804Mbps/sec for the 5GHz one.

The router's local web interface provides only a basic status view and,



to manage it, you assign it to your Nebula cloud account. This is easy enough to do: we used the Nebula iOS app on an iPad to scan the QR code on its base and add it to our site.

The device appears in the Nebula dashboard as a new security router, and the main view can be easily customised. Dedicated widgets are provided for the router's uptime and firmware status, threat detection by category and client, the top ten apps discovered by the application identification service and an OS chart of connected clients.

For wireless services, you can create up to eight site SSIDs each with their own WPA2 or WPA3 authentication scheme and decide which radios are active on each one.

ABOVE The tiny USG Lite 60AX has been designed to sit on a desk

"Nebula's threat report provides an activity graph, a map showing the countries they're coming from and threats by category and client"

Setting the guest option on an SSID enables L2 isolation so wireless clients can't see each other. You can assign custom captive portals with your own logos and greeting messages, a walled garden and clickthrough, voucher, Facebook or Nebula authentication.

Wireless performance will depend on whether the application identification service is enabled – when testing Zyxel's SCR 50AXE desktop router (see issue 350, p99), we found it hit wireless speeds by up to 50%. Fortunately, the USG Lite 60AX has a more powerful quad-core 2GHz CPU so its impact was far less concerning.

We tested with a Lenovo Windows 11 Pro 24H2 client equipped with a TP-Link Archer TBE550E Wi-Fi 7 PCI-E adapter. With application identification disabled, we recorded close-range file copy speeds between the client and a server on the 2.5GbE LAN of 164MB/sec, which dropped by 16.5% to 137MB/sec with it turned on.

The six threat management components are accessed from the Nebula security router settings page and can be enabled or disabled using slider bars. Nebula's threat report provides an activity graph, a map showing the countries they're coming from and tables of threats by category and client, with

the latter allowing you to instantly block systems if their hit rate is excessive.

Application identification provides options to apply custom app blocking

lists and traffic shaping rules for selected clients. The Elite Pack licence is well worth considering as its web content filtering presents 103 URL categories and access can also be fine-tuned for clients or IP addresses.

The USG Lite 60AX is a great entry-level security router, and lifetime support for Zyxel's Security Cloud service means there are no ongoing costs to worry about. Application identification does have a modest impact on performance but it delivers a fine range of security features, and businesses with remote workers will appreciate Zyxel's Nebula cloud management.

SPECIFICATIONS

AX6000 dual-band 802.11ax router • 2GHz quad-core CPU • 1GB RAM • 4 x internal aerials • 2 x 2.5GbE (WAN, LAN), 4 x gigabit LAN • 12V external PSU • integral desk stand • 162 x 65 x 229mm (WDH) • 707g • lifetime Zyxel Security Cloud subscription • 2yr hardware warranty



BELOW Zyxel's Nebula cloud portal provides remote management



Owl Labs Meeting Owl 4+

The Owl 4+ puts the magic in meetings with its 4K camera and smart 360-degree sound and vision

SCORE ★★★★★

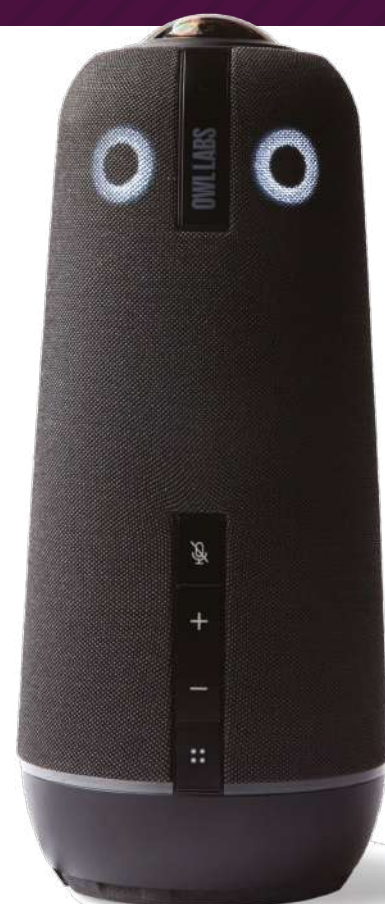
PRICE £1,665 exc VAT
from owllabs.co.uk

The Meeting Owl products from Owl Labs have consistently been among the most innovative hybrid videoconferencing (VC) solutions on the market, and the Meeting Owl 4+ comes with even more appeal. Previously, the Owl Pro and Owl 3 (see issue 340, p98) offered a comparatively low 1080p resolution, but the Owl 4+ sports a new 64MP fish-eye camera that boosts video output to 4K Ultra HD.

There's more going on inside, as it gets a faster Snapdragon 8250 SoC – the same as used by the 4K Owl Bar. The extra power has been put to good use by the Owl Intelligence System (OIS) software as businesses can pair multiple Owl devices together to provide total in-room coverage.

The Owl 4+ sports the same array of eight microphones as the Owl 3, which it uses to identify speakers. The smart part is the video feed: the Owl 4+ presents a 360-degree panoramic view across the top of the screen, dynamically splits the main display below to show the three most recent speakers and zeros in on the person currently speaking.

The internal speaker count has been reduced from three to two, but output quality is undiminished. Comparisons with an Owl Pro found that the Owl 4+ was just as loud at maximum volume but delivered a much cleaner sound quality, with its



heavier body producing a warmer bass without the shrillness of the Owl Pro.

Other improvements are an integral K-Lock security slot and an option to turn off the white LED “eyes” if they become a distraction. The Owl 4+ comes with an external power supply that can be replaced with an optional Power over Ethernet (PoE) network adapter, which has the part number ACCMTW405-0006 and costs around £75.

Installation is a breeze. After plugging the Owl 4+ into a Windows 11 Pro desktop PC, it loaded all the required drivers and defaulted to the split-screen mode.

Management options abound: the free Owl mobile app connects over Bluetooth and provides tools to register the

LEFT The distinctive Owl 4+ boosts video output to 4K

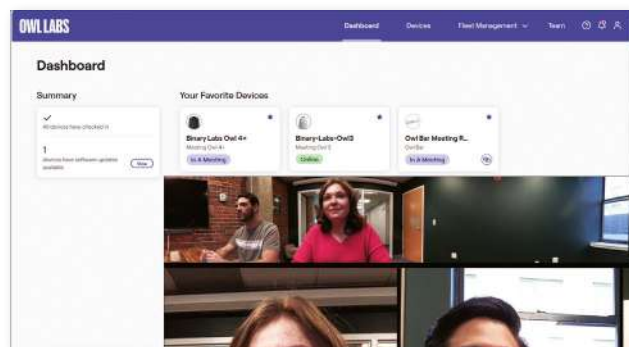
“You’ll be impressed when you first use it as the video display is quite remarkable and noticeably sharper than the Owl 3”



BELOW The controls on the device are straightforward



LEFT The Owl 4+ can be managed from the cloud or mobile app



device and connect it to a wireless network for software updates. You can also enable remote management from the Owl Nest cloud portal, and meeting room analytics.

Using the iOS app on an iPad, we could passcode-protect Bluetooth access, choose the central point for the 360-panoramic view or disable it,

set the camera to lock and focus on one person or follow a presenter. You can turn off the video feed and control the volume during meetings and use a whiteboard to present notes and diagrams to attendees, replacing the split screen in their session window.

The Owl 4+ supports all popular VC platforms, and we had no problems using Teams, Zoom and Skype. You’ll be impressed when you first use it as the video display is quite remarkable and noticeably sharper than the Owl 3.

During meetings, it maintained the full-room panoramic view at the top and swapped effortlessly between active speakers in the split screen below. It’s fast, too, taking around two seconds to swap from one active speaker to another, with the slide animation placing up to three participants in the main view. During small round-table meetings, we found a 50% volume level was quite sufficient and remote

participants could hear us clearly, even when three metres away from the table.

Pairing the Owl 4+ with an Owl Bar is easy, as you place them within two-and-a-half metres of each other with their front logos facing off and use the mobile app to pair them, after which they’ll use their tracking algorithms to choose the best view. No more looking at the back of people’s heads if they turn away from the Owl Bar, as the Owl 4+ takes over so they’re always looking directly at you.

For fully immersive meetings, nobody does it better than Owl Labs. The Owl 4+ delivers excellent video quality plus super-smooth speaker tracking, and pairing it with an Owl Bar covers every meeting room angle. **DAVE MITCHELL**

SPECIFICATIONS

Fish-eye 64MP lens • 360-degree FoV • 4K Ultra HD • 8-core Qualcomm Snapdragon 8250 SoC • 8 mic array • two internal speakers • Bluetooth • Wi-Fi 5 (management) • USB-C • mini-HDMI for mic pod • external PSU with 1.5m cable • 2m USB-C cable • 116 x 116 x 275mm (WDH) • 1.5kg • 2yr limited hardware warranty. **Options:** PoE Ethernet adapter, £75 exc VAT

TP-Link Omada EAP783

TP-Link offers early adopters an affordable business Wi-Fi 7 AP with great performance and fine cloud management

SCORE ★★★★★

PRICE £520 exc VAT
from senetic.co.uk

TP-Link's first Wi-Fi 7 business access point (AP) sets a high standard for the rest to follow, as this slimline discus has a mighty BE19000 rating. The EAP783 achieves this with a claimed 1,376Mbps/sec on the 2.4GHz radio, 5,760Mbps/sec on 5GHz and a speedy 11,520Mbps/sec on 6GHz, with the latter enabling the ultrawide Wi-Fi 7 320MHz channels.

It's also one of the first APs to support the multi-link operation (MLO) feature, which allows devices to connect to the 2.4GHz, 5GHz and 6GHz bands simultaneously for increased throughput and reduced latency. The only downside is that very few end-user devices currently support MLO, and Windows users will have to wait until Windows 11 24H2 is fully released.

The EAP783 has other appealing credentials. It provides two 10GbE ports, with the first requiring an 802.3bt PoE++ power source; there's also an input for TP-Link's optional 12V adapter. The second 10GbE port is designed to be aggregated with the primary network port for a higher network connection speed.

Despite the AP's 12 internal aerials, TP-Link has kept the size down to a

manageable 280mm diameter and a thickness of 47mm. It's heavy, though, tipping the scales at 1.4kg – around 15g more than Zyxel's WBE660S.

The EAP783 supports standalone mode, where the web console's quick start wizard requests a new username and password, after which it removes the default admin account for extra security. Eight SSIDs per radio can be created, and the wizard asks you to configure the first three and provide new encryption keys.

For our real-world Wi-Fi 7 performance tests we connected the AP to the lab's Zyxel XS1930-12HP 10GbE PoE++ switch and used a Lenovo desktop client running Windows 11 Pro 24H2 Insider Preview and fitted with a TP-Link Archer TBE550S Wi-Fi 7 PCI-E adapter. With Windows reporting a Wi-Fi 7 connection speed of 5,764Mbps/sec, we saw large file copies between the client and a Windows server

on our 10GbE LAN averaging close-range speeds of 323MB/sec, dropping to an equally impressive 280MB/sec with the AP placed ten metres away in an adjoining room.

The web console provides a separate section for MLO where you create a new SSID and decide which of the three radios to assign to it. Performance-wise, we saw no benefits from a triple radio MLO SSID as the Windows 11

client reported the same speed as a standard Wi-Fi 7 connection and our copies were no faster.

TP-Link offers plenty of cloud management choices. You can deploy its hardware or free software controller on-site or use its cloud-hosted controller, which has a yearly fee of £165 for 250 devices.

We use TP-Link's OC300 dual-port controller appliance in the lab as its £130

price enables lifetime cloud management of up to 500 Omada APs, switches and routers.

All controllers are viewed from the Omada portal home page, and selecting the OC300 transported us to its own console. This presents a ribbon across the top showing all cloud-managed devices, and selecting a site below provides options to create multiple dashboards with a wide range of widgets.

The EAP783 initially appears as "pending" in the portal, and all you do is adopt it and assign it to a site. It only takes a minute, after which the AP disables its local web interface for security reasons, takes all its settings from the controller and broadcasts your preconfigured SSIDs.

It's easy to add more SSIDs, apply a desired personal or enterprise encryption scheme, set client and SSID rate limits and define schedules to determine when they're active. For the EAP783, we could enable any of all of its three radios, and we noted the portal has an option to create MLO Wi-Fi 7 SSIDs.

The EAP783 will appeal to businesses looking to make an early transition to Wi-Fi 7. It delivers excellent performance and is MLO-ready, and TP-Link's Omada cloud platform offers great remote management services. **DAVE MITCHELL**

SPECIFICATIONS

BE19000 tri-band 2.4GHz/5GHz/6GHz 802.11be • 12 x internal aerials • 10GbE LAN/802.3bt PoE++ • 10GbE LAN • ceiling/wall-mounting kit • 280 x 280 x 47mm (WDH) • 1.4kg • DC power adapter not included • standalone or Omada cloud management • limited lifetime warranty



ABOVE The Omada EAP783 provides speedy Wi-Fi 7 performance

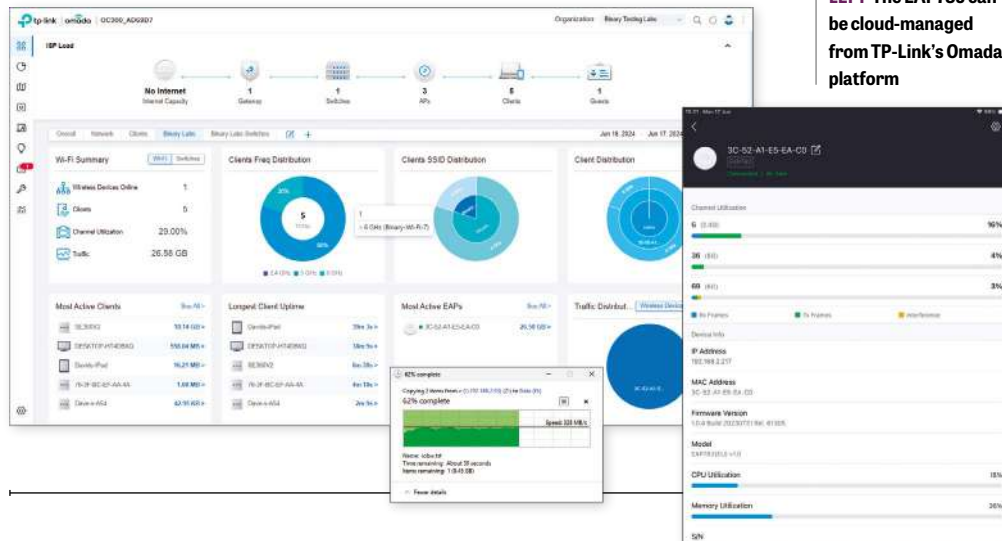


"The EAP783 will appeal to businesses looking to make an early transition to Wi-Fi 7. It delivers excellent performance"

LEFT The AP comes with two 10GbE ports



LEFT The EAP783 can be cloud-managed from TP-Link's Omada platform





Market and advertise your small business online

Internet marketing can be a fantastic tool – if you use it effectively. **Nik Rawlinson** delves into the world of pay-per-click



Promoting your product or service is a serious business. Large organisations have whole departments dedicated to the task, staffed with marketing experts and following the latest trends on every social and advertising network. Many work with external creative agencies, and have the kind of budget that justifies a dedicated account manager at each outlet.

For smaller businesses it's a different story. In this sector you usually need to manage your own advertising spend, decide for yourself how to allocate it across diverse networks and different markets, and even design your own ads.

Knowing where to direct your efforts can be confusing to begin with, and a little bit of trial and error when you're starting out is inevitable. However, understanding how the various options compare and what they might cost will go a long way, at least in the early days.

■ Social is(n't) the answer

The first question to consider is whether conventional advertising is your best (or only) option. There are around 67 million people in the UK, and analysts estimate that more than 56 million of them use social media to

some extent, so posting online content can be a powerful way to get your brand, product or services in front of a vast audience for almost no outlay.

However, relying solely on social media to build your brand is like relying on the lottery to make you rich. While it might work, there's certainly no guarantee. A small number of accounts have very large followings and highly active followers, but most have just a few thousand or fewer – and, especially if you're just starting out on a platform, it's very likely your business will fall into the latter category. You may choose to pay for advertisements to give your content a boost, but otherwise, unless you have a unique proposition or celebrity endorsement, you'll need to play the long game.

You can maximise your chances of getting attention by posting at times when your followers are most likely to see your content. In general, first thing in the morning and just before lunch are reckoned to be effective on networks such as Instagram and Facebook, while weekend posting is thought to be less effective. But it's worth testing whether this is true for your audience; don't assume that all demographics will use social platforms in the same way.

“Relying solely on social media to build your brand is like relying on the lottery to make you rich”

While you might think it's good to be visible, posting just for the sake of it can actually harm your reach. All social networks want to increase dwell time, which means serving engaging content to their subscribers; if your content isn't being liked, shared, bookmarked or commented on, it's likely to be deprioritised by the algorithm over time. Instagram openly explains that when deciding

which posts to include in a user's feed, “we consider recent posts shared by the people you follow, as well as posts from accounts you don't already follow that we think you might be interested in. We determine

what you might be interested in based on a variety of factors, including what and whom you've followed, liked or engaged with recently. We personalise the experience for you to try to strike a balance between content from accounts you follow with content from accounts you don't follow but might be interested in.”

You also need to be sure that your content is tailored to the platform – in the right style and the right format, be that video, photo, text or something else entirely. As well as the reputation of your account, the algorithm

considers how the content you're posting will render in the device the visitor is using, whether they seem to prefer photos to videos, what kind of format they engage with most often and so on.

If you're thinking that this is a lot to try to stay on top of, we're inclined to agree. It's not realistic to try to weigh all these factors into every post – never mind the fact that Instagram uses different criteria to promote stories, reels and so on. The best approach may therefore be to treat your potential audience as an extended friendship group, and engage with their content in the hope they'll do the same with yours in return. As an example, look how much success Ryanair is having with its unconventional interactions on social media, which win followers and are frequently shared.

Finding the best audience may also mean venturing on to unfamiliar networks. Facebook is often the best place to start, with around 46 million UK users of all ages. However, if you focus solely on that platform you risk missing the many millions who spend more time on YouTube or Instagram.

Win friends and influence people

Rather than trying to build up a following from scratch, many brands work with established influencers to help them reach a particular target audience. There are hundreds of such individuals out there, with different styles and specialisms. The Influencer Marketing Hub (influencermarketinghub.com) ranks influencers according to their followers, so "nano-influencers" are those with between 1,000 and 10,000 followers, while "mega influencers" have more than a million, and micro, mid-tier and macro influencers sit in between.

The Hub can also provide an idea of what you should expect to pay for a collaboration in each category and on each social network. For example, if you want a mega influencer to post about you on Instagram you can expect to spend in excess of \$10,000; TikTok and X/Twitter are considerably cheaper, but even mid-tier influencers can demand up to \$12,500 for a sponsored video on Facebook – and you can at least double that for a mega influencer.

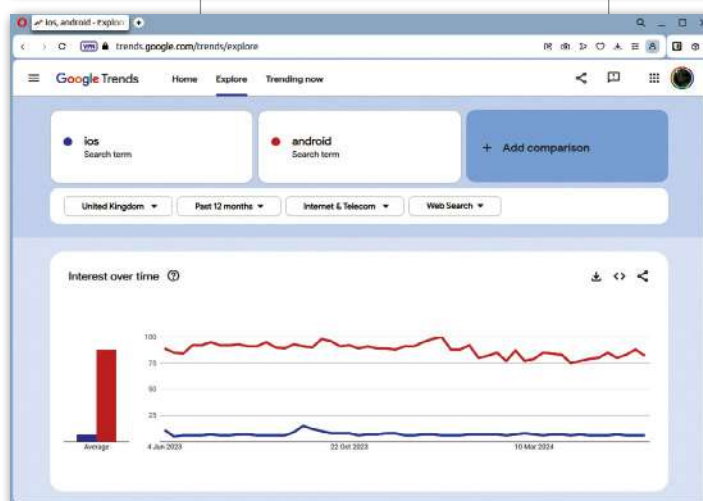
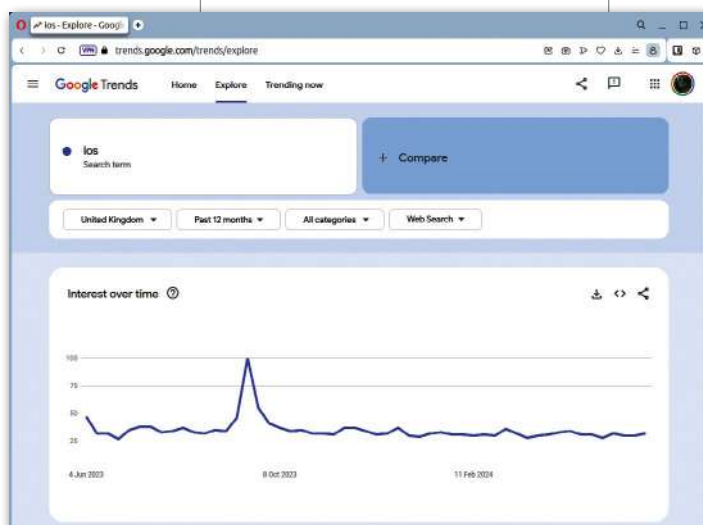
Be aware, too, that when you engage an influencer, you have limited control over the message: they'll cover you in a way that suits their personal brand and their audience. If they've agreed to a paid promotion then you can reasonably expect them to be positive about your product or service, but if you want to

focus on a particular marketing angle, this might not be the right route.

Online advertising

If content-focused marketing isn't getting you where you want to be, you may need to invest in some straight-up advertising, to drive people to your posts or your profile page. This approach doesn't have the glamour of working with an influencer, and it may not reach as many people in a single hit, but it's usually less expensive – so you can roll out a wider, longer-term campaign on the same budget, while retaining full control over the focus and format.

BELOW A spike in search traffic for "iOS" coincided with the launch of iPhone 15



ABOVE "Android" generates considerably more Google search traffic than "iOS"

Using conventional ads doesn't necessarily mean you won't reach an influencer's audience, either. By targeting appropriate platforms and keywords, you may be able to get your message right next to some very expensive influencer content. The challenge is to get that targeting right, so you're reaching the most relevant and receptive audience.

When working out how to position your ads, your first stop should be Google Trends (trends.google.com). This hugely valuable resource is home to a huge historical archive of what

users have been searching for on Google over the years, and while older data is primarily of academic interest, you can track trends over recent months and years to inform your marketing activities.

Using Google Trends is simple: point your browser at trends.google.com, then type a keyword into the search box. For the sake of example, let's imagine we've produced a gaming app that's available for both Apple and Android mobile devices, and we want to understand how best to split our marketing efforts between the platforms. In this instance, we might initially search for "iOS", with a view to targeting people who search for this term.

A graph appears showing a fairly sustained level of interest in this search term, with a peak in late September 2023 coinciding with the launch of the iPhone 15. Note that this is a global picture: if we plan to sell only in the UK, we can restrict the results to our target audience, by selecting United Kingdom from the Worldwide menu beneath our search term.

Let's check how this compares to Android by typing that in the "+ Compare" box. We can immediately see that the term "Android" tends to attract around three times as much search traffic as "iOS". And when we restrict the data to just "Internet & Telecom" sites (by selecting this category from the third menu), Android represents between ten and 20 times the amount of traffic.

You might assume that this means the Android audience is the best one to target. But it's worth trying some alternative terms. Let's now try clicking "+ Add

comparison" and typing "iphone". Suddenly, Android is dwarfed. Once again, we can use this data to inform our decisions, choosing either to target people searching for "iPhone" and "Android", or to stick with "iOS" in the hope that we'll win ourselves a niche in a less competitive market.

If you want to drill down further, the geographic location menu lets you target the four nations of the UK individually, while the Web Search menu at the far right of the block lets you switch between web, image, news, shopping and YouTube results.

■ Set your budget and buy your ads

No matter how carefully you choose the keywords you want to target, a major quirk of online advertising is that it's impossible to say with certainty precisely where your ads will appear. Advertising networks may place ads on their own properties, such as in a Facebook feed, or on third-party sites, like some of those served by Google. What's more, there's no guarantee of how often your ads will be shown or how many people will see them.

This is partly because the advertising hosts dynamically seek to put your ads in the most advantageous positions. They'll generally segment the audiences to which they show ads, grouping potential viewers by interests, gender, age, location and so on, and then use these data points to decide which ads are most likely to be of interest to each pair of eyes.

This means you can maximise your return on advertising spend by going in with a clear picture of the demographic you want to target. In the above example of our app, we obviously want our ad to be seen by people with smartphones, but that's far too broad a definition to be of any use; only a tiny proportion of people searching for the word "iphone" are likely to have any interest in our product. We need to refine the target audience so our ad is shown only to people with an interest in mobile gaming – or, ideally, mobile strategy gaming with a focus on the Roman conquest of Europe, if that's the genre into which the game falls.

The other part of the equation is the knotty question of just how much you're willing to pay for every ad that's shown. Every time a page containing an advertising spot is loaded, the advertising server checks what it knows about the user, identifies which adverts might be relevant, and chooses which ones to display – and a big factor is how much the different advertisers have indicated they're willing to pay. If you want to advertise against a common term such as "iphone", you may need to spend big, as many rivals will be vying for exposure with the same keyword.

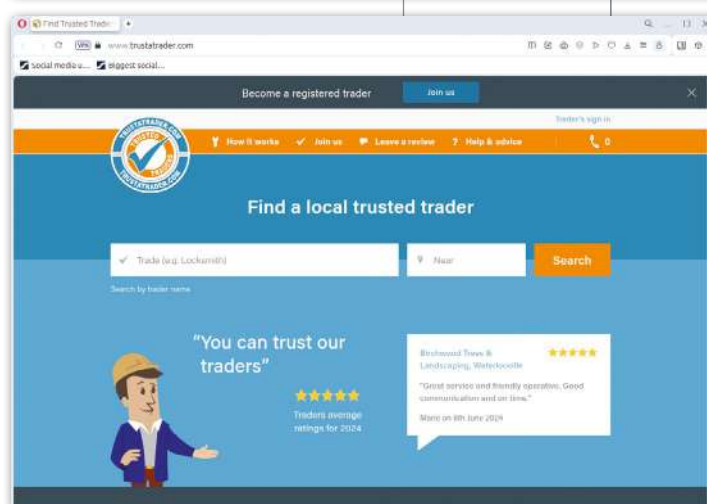
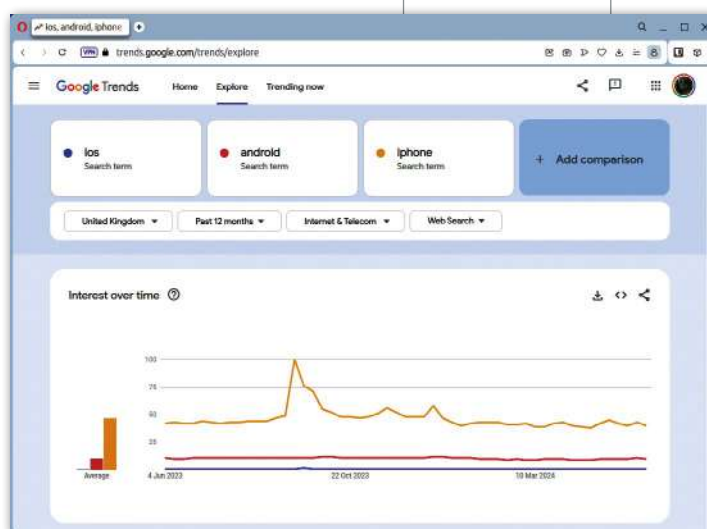
Demographics and price aren't the only considerations. Meta, for example, says it also considers the quality of the ad itself, as determined from "sources including feedback from people viewing or hiding the ad, and assessments of low-quality attributes in the ad, such as withholding information, sensationalised language and engagement bait". In other words,

while you want to produce an ad that induces people to click on it, you may be harming your own prospects if your content isn't clear and honest.

Gauging how much to spend to maximise the impact of your campaign can be tricky. Bid too much and you can easily overspend, compared to the value of the campaign. Go too low and your ads might never be seen. The networks themselves can help you work out a starting point by estimating how many times your ad will be shown based on your targeting and budget – and, as they deliver comprehensive

"You can maximise your return on advertising spend by going in with a clear picture of the demographic you want to target"

BELOW Testing alternative search terms can help you find the best ones to target



ongoing analytics, they can also help you refine your budget allocation over time.

One good approach, certainly to start with, is not to put all your eggs in one basket. Define several target groups, produce unique adverts for each one, and split your marketing budget between them. You can then monitor how each one goes and refine your advertising strategy as you go, based on real-world results.

■ Closer to home

A final factor to consider is geography. Not everyone is selling

nationwide, worldwide or even remotely; many small businesses deal directly with customers in a tightly defined locale.

That doesn't mean online advertising is out of the question. Google, Facebook and others can also facilitate local advertising. Google's Local Services Ads (tinyurl.com/360localads), for example, can be particularly helpful for companies that deal with other businesses in their local area. You can design your own ad in the browser, complete with contact information and imagery if you choose, and then manage your ongoing ad spend just as with more general campaigns. While online advertising may not completely replace physical posters and mailshots, it has the big advantage of zero up-front costs – you only pay when your ad is clicked on.

Meta can likewise use what it knows about its audience to help you target local customers, and show your ad to nearby users of Facebook, Instagram and WhatsApp. The only prerequisite here is that your business needs to have its own Facebook page, so make sure you've set this up before you start vying for custom.

It's worth looking at other local online directories too, such as Trust a Trader (trustatrader.com) and Trust a Garage (trustagarage.com). These work in a slightly different manner: membership is limited both within professions and across geographical areas, so if there's a glut

of similar trades operating in your neighbourhood, you may have to wait your turn.

These sites also charge an annual fee for membership, rather than operating an auction model, and they gather customer feedback so that future prospective customers can have confidence in the trader they're booking. If you score less than 60% in feedback on a job sourced through Trust a Trader, the site will launch an investigation before publishing the feedback to make sure it's justified, which offers some protection against potentially unreasonable customers. ●

ABOVE Directory sites such as Trust a Trader offer a more traditional model for local tradespeople

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Real world computing

Expert advice from our panel of professionals

JON HONEYBALL

“You hope your antivirus product is on your side. You can assume that malware is not. But the similarities are striking”

Now that the US government has banned Russian software, should you do the same? Plus Jon's take on Microsoft repeating history with Recall

The US government has decided to take terminal action against Kaspersky, that well-known supplier of antivirus and other related security software.

The writing has been on the wall for a while: a few years ago, it banned use of Kaspersky software on government computers. But now it has issued a ruling that it can't be sold at all to new customers after 20 July, and that it won't be allowed to issue updates and antivirus signatures after midnight on 29 September 2024. Which means, of course, that its effectiveness as protection will quickly fade away because much of the risk comes from new and emerging malware.

Existing customers won't be banned from continuing to use the software after that date, but it would probably be unwise.

Why has the USA done this? Well, it maintains that “Kaspersky's products and services pose an unacceptable risk to United States national security and the security and safety of US persons, and an undue risk of subversion of, or sabotage to, the integrity and operation of Information and Communications Technology and Services (ICTS) in the United States. In particular, there is a significant risk of harm to the integrity and operation of ICTS and the ICTS supply chain in the United States.”

This is a very strong statement that cannot be overlooked.

Now, we must presume that the US government has some reason to take this position. And some strong claims

have been made by the US Office of the Director of Intelligence in particular (tinyurl.com/360-usoffice). Specifically, that Russian intelligence services (RIS) has access to US customer data facilitated by Kaspersky. That “former RIS officers employed by Kaspersky, which include the founder and CEO and a number of executives, use their positions and access to maintain cooperation and share identifying client data with current RIS officers”. That “FSB (the Russian Federal Security Service) can legally direct KL to provide user data, modify software or hardware, and perform searches on end-user systems” and that “Kaspersky provides contract services to the Russian government and pursues business decisions that serve Moscow's offensive and defensive interests”.

The problem, of course, is that we have no way of knowing just how much substance there is behind this. There could be solid proof that Kaspersky has been sending information to the Russian government. Or it could be part of the ongoing international war of words between the US and Russia, no doubt fuelled by the invasion of Ukraine. We simply don't know, so I'm not going to proffer an opinion here.

What is important, however, is to remember what an antivirus product does and how it works. It has been, somewhat cruelly, defined as “exactly the same as malware, except for intent”. An AV product requires access to all areas of the hard disk, including operating system areas.



Jon is the MD of an IT consultancy that specialises in testing and deploying kit
[@jonhoneyball](https://twitter.com/jonhoneyball)

“The problem is that we have no way of knowing just how much substance is behind this”

BELOW The US intelligence service has made some strong criticism of Kaspersky

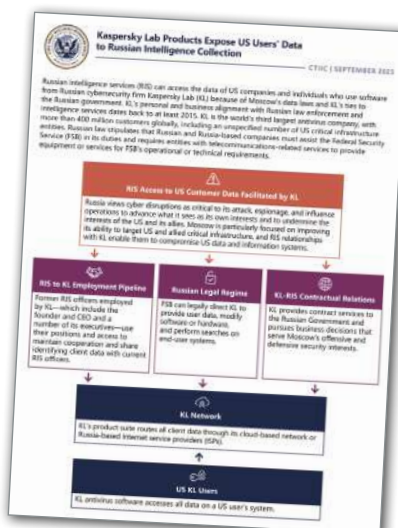
It does this by installing a file system filter in the operating system so all traffic, both reading and writing, is channelled through a small layer owned by the AV product. And from this it can see all traffic, and scan this as appropriate.

It also inserts itself into the networking stack, so it can see all IP traffic, too. But this comes with a significant limitation: most traffic these days is end-to-end encrypted. So how does it get around this? Well, it usually installs a root certificate into the operating system's certificate store, thus allowing it to read any encrypted SSL/TLS traffic going between, for example, your browser and a cloud service. And hence this can quite happily read your banking information if you're online to your bank from a browser. If an app uses an entirely separate private key infrastructure, then it can't get into that. But for most traffic, for most users, everything is laid bare.

AV products use cloud technologies in the identification of malware. So it's entirely possible that an AV product might send a file

to its cloud services for analysis. We could get into the minutiae of where those servers are held, and under which jurisdiction. But the underlying point remains. A modern, well-crafted antivirus security product has, in effect, access to everything.

This same capability is what malware wants: access to your files, your data and your ongoing communication streams. It might use similar techniques, or rely on programming errors such as buffer overflows and other methods to get its own





Jon Honeyball

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Lee Grant

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Dr Rois Ni Thuama

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Davey Winder

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Steve Cassidy

The wider vision on cloud and infrastructure – p122

obfuscated code onto your computer. And often these can be extremely sophisticated platforms, relying on multiple, seemingly unrelated, bugs and errors. But if you can string it all together, and then target the user, you might get your malware onto their device. Such work is not simple, which is why there are increasing worries about nation state actors working in this field. Although we will never get rid of the script kiddie in their bedroom in Reading having a poke around the internet, it's much more concerning when a national state is funding such work.

And that's why I say, with only a wry smile, that the difference between malware and antivirus products is one of intent. You hope that your AV product is on your side. You can rightly assume that malware is not. But the similarities are somewhat striking.

So the claims by the US government that Kaspersky has access to everything on a computer on which its software is installed is pretty much correct. The question is whether you trust Kaspersky or not. And the US government has decided that it doesn't.

There are, of course, a few interesting things falling out from this. If you've paid for an annual subscription, will Kaspersky be forced to issue refunds? I've had a poke around its various licences and can't see anything that appears to let it out of this, but I'm not a lawyer.

And is this just part of the ongoing collapse of the 1990s dream of an open World Wide Web? I wouldn't disagree that we were positively naive in our vision, and generated a whole heap of technologies that were fundamentally insecure. And we've done relatively little in the meantime to make things better. When was the last time you received an email that had a digital certificate attached proving the identity of the sender? No, me neither.

Although this ban doesn't affect the UK and EU, there's always the possibility that governments will move in lock-step. I wouldn't advise jumping off Kaspersky because of the US ban, but good

security policy demands that appropriate risk assessment is performed, whether you're a large corporation or a single user at home. And this must be tempered by an appropriate understanding of just what an AV product does and how it works. For myself, I would be pretty content with the built-in Defender antivirus on Windows. And then to add an appropriate smattering of filtering tools, ad-blocking tools and other scrubbing capabilities into my browsers.

At the end of the day, AV is not the be-all and end-all; it's just part of a bigger picture. Security should be considered carefully: are you protecting the integrity of the computer itself? Of your data on it? Of your transactions onto the internet? Each has a different set of needs and outcomes, and there's no one-size-fits-all solution. Defender plus browser extensions plus a robust backup solution, both on-site and encrypted offsite, is likely to cover most needs. Serious people have much stronger systems, culminating in air-gapping the network both from the internet and other networks within an organisation. A sensible balance is required.

Overloaded Windows title bars

I can't be the only person who is getting quite frustrated by the current fad for loading up the title bar of an application's window with all sorts of cruft. Icons, quick access buttons and various other useless stuff goes in there. It's now getting



ABOVE The US decision may have more to do with global politics than tech

“At the end of the day, AV is not the be-all and end-all; it's just part of a bigger picture”

BELOW How much more cruft can fit on to an app's toolbar?

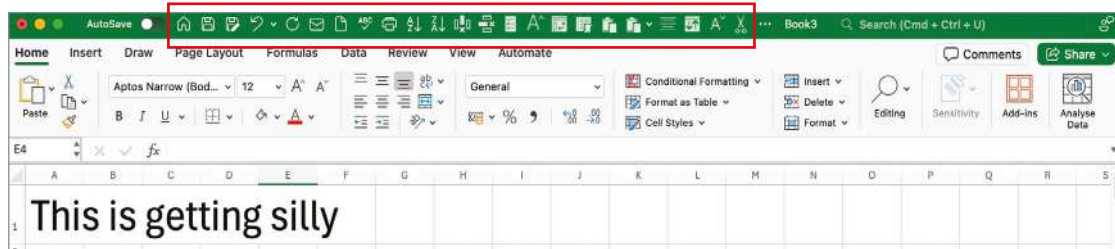
quite hard to know where to click on a title bar to move a window around the screen, for fear of firing off one of these things.

It's just as bad on Windows as macOS, too, and a particularly annoying one is the Discord platform we use for the *PC Pro* podcast and forum (pcpro.link/discord to join). There's almost nowhere left to click, and I'm not amused by this at all.

Gurgle clock DHCP

I knew something was amiss with DHCP when one of my UniFi switches reported that its IP address was 192.168.4.x. Which was worrying because the IP address range of that network is 10.101.x.x. I dropped a computer onto the 192.168.4.x range and did an IP scan, but nothing could be found. So something was appearing on the network, and was serving up DHCP address requests. It clearly wasn't there all the time, because I couldn't find it.

Something was nagging at the back of my mind about that IP range, though; I'd seen it somewhere before. And then I remembered: that utterly





ABOVE Is Microsoft making the same mistake with Recall as it did with WinFS?

“Everything from Redmond these days must have some sort of AI spin to its marketing”

BELOW A digital clock from GurgleApps has been messing with my IP addresses

delicious **GurgleApps.com** digital clock that I mentioned a month or so ago, put together by a family who have an excellent and inspirational YouTube channel.

By default, the clock acts as a Wi-Fi hotspot, so you can connect to it, and then point a web browser at the configuration page at 192.168.4.1. In here, you can give it the SSID and password of your Wi-Fi, at which point the clock can then hop on to the local network to get its time from an internet time server.

In order for the Wi-Fi hotspot to work properly, it needs a DHCP server on the clock, to hand out an IP address to the connecting computer. However, it seems that the DHCP server is, or could be, bound to the Wi-Fi client side too. So the clock's DHCP server ends up on my local network.

I sent an email off to the team at Gurgle, and it has identified a bug in the binding of the DHCP server to both the hotspot Wi-Fi and also to the client side. They're looking into it. In the meantime, I simply don't allow the clock to log into my local Wi-Fi network, and the problem has gone away.

Now this is yet another example where long-standing IP technologies were a good idea at the time, but were not really designed with security or robustness in mind. It's perfectly simple to put two DHCP servers on to one network, and chaos can result.

It's also a good reminder that I really should set up a separate VLAN for this, and control the routing on the router, to ensure such an IoT

device can't actually connect to other devices on the network. This is simple enough to do on the UniFi platform here, which runs the networking infrastructure, but I would have to delve into the pfSense router/firewall to configure that. My workaround will do for the time being, but I'm getting tempted to replace the pfSense firewall with the new UniFi DreamMachine Pro Max unit. It's just a matter of finding the time to rebuild the network over a weekend, and gain access to the data centre at Merula so I can physically access the boundary router/firewall.

Microsoft Recall

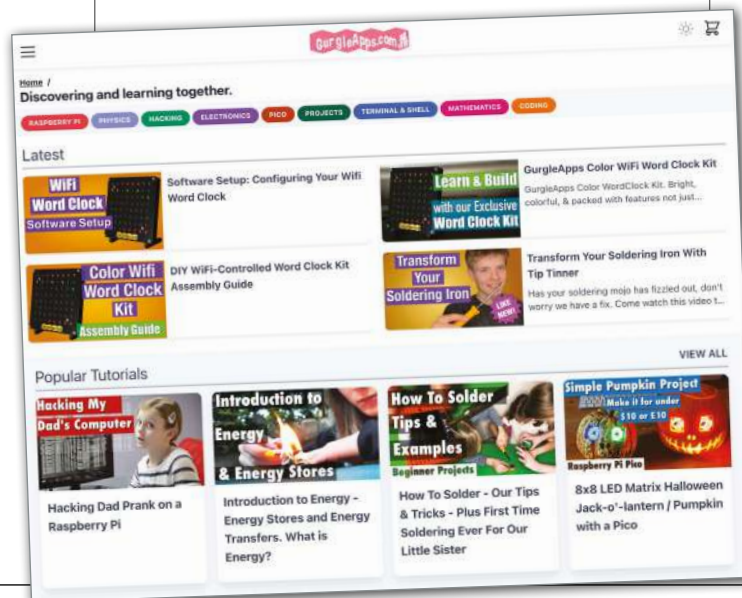
There's been quite a lot of upset about the proposed Microsoft Recall tool coming on Windows 11. Or more specifically, on the Copilot+ PCs, including those that run on the latest Qualcomm Snapdragon X processors such as the Microsoft Surface Laptop (see p50), which are only just going on sale.

This version of Windows is being hailed by some as being the saviour of the Windows platform, which has been taking quite a battering in comparison with the Apple M-based laptops. That's not only in performance terms, but also in battery life. Despite the efforts of Intel and AMD, they just don't seem to be able to match the efficiency of the Arm-based processors. You might, quite reasonably, have assumed that the existing Windows 11 laptops based on the previous Qualcomm/Microsoft Arm processors would be just as good, but they never really made the grade. And that's despite the Windows on Arm platform making significant improvements over the past few years, with the 64-bit Intel-to-Arm code translator helping considerably.

But Microsoft is pushing a new generation of AI oriented Arm-based devices for Windows, the aforementioned Copilot+ PCs, based around the Snapdragon X family. And because everything from Redmond these days must have some sort of AI spin to its marketing, it was inevitable that these laptops would get the same. First, note that these capabilities aren't available on the Intel and AMD versions of the Windows platform, as the NPUs built into their current chips don't meet the criteria. All that will change later this year when AMD and Intel release new processors to laptop makers.

Back to Recall. This is a technology that, in essence, tries to remember what you've been doing and what you've read on the screen. To do this, it screenshots the display every few seconds and then does an OCR to pull out the textual content. I assume it does this knowing where the various windows are located, so it doesn't mix up two windows into one text blob.

There was very limited external beta testing of this, and when some researchers got their hands on it, they found significant issues with the beta build. The data was stored in an unencrypted database, for example. At this point, the story blew up, and Microsoft was forced to admit that there were security parts still missing from the beta, and then it decided to put the whole thing on hold, thus driving a road digger through some of its expected PR and marketing for this new platform.



My good friend Wes Miller, who was part of the Windows team in the early noughties and is now the expert at Directions on Microsoft, the independent think tank, wrote a blog post comparing Recall to WinFS, the abortive attempt to put an object file system into Windows based around SQL Server (see tinyurl.com/36ogetwired). This wasn't Microsoft's first attempt either, with the previous abortive Cairo Object File System in the 1990s as a painful memory.

Wes posits that exactly the same mistakes have been made yet again: demand from on high for something big and flashy; poor implementation and little consideration of how it will actually be used by real, paying customers, leading to a painful and public climbdown.

I remember WinFS well. I visited Redmond back then to meet the team, and was running early builds of the code for a while. And what Wes says about it is entirely correct. And I suspect he will be just as right in his comparison with how Recall is unfolding, too.

Apple versus EU

I have just heard that Apple has announced that many of the new features of the forthcoming iOS 18 and macOS platforms won't be available in the EU because of concerns over the implementation of the Digital Markets Act (DMA).

Of course, there are many layers to the onion here. In particular, Apple wants to get its marketing spin out there now, as part of its ongoing war with the legislators in Brussels. But it opens up an interesting question: at what point does even something as simple as working with the cloud service require that a competitor can demand to be part of that process? Will Facebook be forced to open up its APIs so that a third party can write an alternative front-end app client? Twitter/X famously removed all the APIs for third parties; will it be forced to reverse that?

The difference is that Apple is deemed to be gatekeeper. But what about Google? This story is going to roll on and lawyers will get richer. Meanwhile, I still have to feed the chickens and water the tomato plants.

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LEE GRANT

"The customer is welcome to buy whatever they wish, but I like to investigate their expectations"

After considering efficient PC cooling, a repair technician from Yorkshire, like many men his age, is trying to work out where the drips are coming from

An email from a regular customer arrived. "How much to fit this to my machine?" I clicked the Amazon link, made a note to thank said customer for shopping locally then gazed in wonder at the Kraken Elite RGB 360 (tinyurl.com/36okraken). What? You've never heard of the Kraken Elite RGB 360? Look out of your cave – all the cool kids are wearing Kraken Elite RGB 360 T-shirts and drinking from Kraken Elite RGB 360 soda cups, and you don't even know what it is.

You're not alone. Like many streams of technology, the Kraken Elite RGB 360's ridiculous product name is neither descriptive nor patronymic. The aforementioned product is an all-in-one (AIO) liquid CPU cooler made by NZXT priced at around £260. It's a beast: a water block, featuring a programmable TFT-LCD display, which pumps coolant through ultra-low evaporation rubber sleeved with nylon braid, into an aluminium radiator that's cooled by three 120mm RGB fans. It comes with an RGB control box so it can be controlled and customised to within an inch of its life, turning the owner's PC into an RGB fairground, while the block's LCD screen will spit out anything at 640 x 640 pixels.

The "Krak El 360" is just the sort of thing that gives PC building a frisson as you work carefully through the mass of cables, slowly bringing the flashy thing to low-noise life.



Lee Grant and his wife have run a repair shop in West Yorkshire for over 20 years
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"The 'Krak El 360' is just the sort of thing that gives PC building a frisson"

BELOW The Kraken Elite RGB 360 can turn your PC into an RGB playground

However, the frisson is replaced with nightmarish frustration when attempting to retro-fit something like this to an already working machine, so my reply didn't deliver the seal-the-deal hammer blow that LinkedIn has told me that businesses should always deploy. "Why do you want this?"

What followed was some hard negotiations. The customer is (of course) welcome to buy whatever they wish, but I like to investigate their expectations as they often differ from reality. The most common example of this would be people asking to swap their laptop battery in the belief it will make their machine faster. You'd also be excused for presuming that I'd be blameless for their disappointment when the expensive 1,000W PSU they've asked me to weave into their PC hasn't made a jot of difference to their gaming performance. I could just shut up and take the money, but ensuring the customer knows what the result will (or won't) be is good service, and also prevents those "that part you fitted doesn't work" disappointments.

In truth, the customer hasn't yet decided if they wish to proceed with the Krak El 360, mainly because it's an expensive part and fitting it isn't a five-minute gig. They've also hesitated due to the warning I gave, which I repeat here should your desktop be cooled by liquid: "AIO coolers can leak".





Floyd on Repair

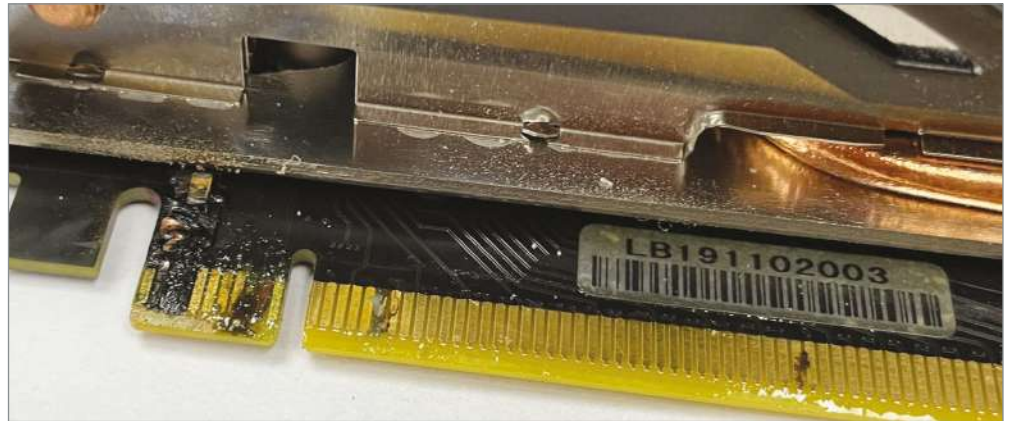
Back in the late spring, a customer arrived with their backup machine, which hadn't been fired up for some time. Under the time-honoured standards dictated by sod's law, the moment it was required, it refused to start.

We'll park the conversation about "always test that your backup is working" and get to the point. I looked into the machine and could see that the GPU was wet. I removed a few more things, wondering how liquid could have penetrated the insides of the desktop. The answer can often be revealed by touching or smelling the liquid. Most alcohols are quite distinctive on the nose, soft drinks are sticky, and hot drinks with milk and/or sugars leave plenty of residue. This liquid, glinting in the machine, was oily and had pooled around the GPU's PCI-E connection.

I couldn't find any other residue within the case. As all the external vents on the machine were covered by fans, it meant that if the liquid was introduced from outside of the chassis, the fans would have distributed it everywhere. Therefore, my dear Watson (puffs on pipe), the leak was internal.

The customer had bought this machine from a well-known PC builder who, like many in the game, uses white-label AIO coolers and then slaps their own branding on them. They're attractive, quiet and functional, unless they leak. The weeping from this CPU block was so slight that it was almost imperceptible to the eye, but a quick dab with blue roll (tinyurl.com/36oblueroll) confirmed it. If the machine had arrived in the shop months earlier, where the evidence glistening on the GPU wasn't present, I'm not sure I would have spotted it.

Sadly, this story doesn't have a happy ending. I don't know what sort of inert coolant had been used inside this AIO, but I suspect that the late chef Keith Floyd (tinyurl.com/36ofloyd) may have approved of its drinkability. The liquid had hit the front end of the GPU's PCI-E slot, which is where the main power rails are located, which had crisped them up in a way that Keith would have accepted for lasagne but is utterly unsuitable for electronics.



ABOVE When liquid reaches your card's PCI-E connector, you're in trouble

As the GPU was in situ, the plastics in the motherboard's PCI-E slot had also been flambéed. Although I did my best to clean it with a vintage isopropyl alcohol (cheers!), it was as salvageable as burnt toast. Ever the optimist, I spotted the CPU was an Intel Core i7-9700, and this particular Eccleston came with Intel UHD 630 onboard graphics. I re-cleaned, I dried, I bolted on an air cooler, wired up the on-board and pushed the button. It was alive.

Using a bootable Windows PE drive, I allowed the machine to sit for a while before I phoned the customer to offer an explanation and a solution. And it's a good job I didn't rush. About 15 minutes in, the PCI-E slot belched magic smoke and emitted a small flame that tracked up and down the board, destroying numerous electronic pathways. It was dead.

This isn't the first time I've seen leaking AIO coolers. Although many of them are robust, if you think about their design – pumping liquid through hosepipes – it becomes important to consider the ramifications of what will happen if they fail.

Some manufacturers try to flag their expected durability, but not in any meaningful way that may detract from sales. A quick glance at NZXT's information for the soon-to-be-legendary Kraken Elite RGB 360

"If you have an AIO, work out how long you've had it, buy some blue roll and keep an eye on it"

BELOW The aptly named Be Quiet cooler is virtually silent



clearly states that the warranty is for six years or 60,000 hours, which is manufacturer speak for "after that, you're on your own pal!" I certainly don't want to cause panic within the PC Pro community, but if you have an AIO, especially a custom-branded, white-label model, then work out how long you've had it, buy some blue roll and keep an eye on it.

The coolest cooler

Clearly, the appeal of many AIOs is their aesthetic and the way RGB lights can be tweaked to achieve mood and effects. You may be surprised at the number of AIOs I discover inside solid panel cases, presumably installed so the vendor could put "liquid cooled" into the blurb and whack the price up a few quid. It cannot be denied that a decent AIO is also near silent, but given the leak-potential I've already mentioned, that's not a good enough reason to inflict one on a client. Recently I was asked to make a machine that was powerful and quiet, so naturally I opted to cool the CPU using a sizeable chunk of metal strapped to two fans.

Be Quiet! (bequiet.com) is a brand I've used for many years. The legendary Formula 1 designer Adrian Newey said that "evolution is often the key to the spark of a good direction has been set", and Be Quiet (let's quietly drop the exclamation mark) is the epitome of Newey's belief. Its whole design ethos is about making PCs as near to silent as possible. To keep my client's Core i7-14700F cool and shtum, I bolted on the company's rather magnificent Dark Rock Pro 5 (tinyurl.com/36odarkrock).

This is a 1.7kg ceramic coated lump of aluminium, beautifully sculptured into a seven-heatpipe formation with a copper base. The two "Silent Wings 4" fans will hit 23.3dB(A) at 100% (the sound of someone breathing from one metre away). At 50%, it hits an unnoticeable 8.9dB(A).

These numbers are astounding for something capable of preventing a 270W chip from boiling over, but

it's also a feast for the eyes, an engineering marvel. To me it looks far more impressive than any AIO, and has a quoted lifespan of 300,000 hours, but its major advantage is that it will never regurgitate coolant over the RTX 4060 which sits beneath it. Be Quiet's integration of the Silent Wings 4 fans is a smart design principle I enjoy because replacement fans are readily available from its site, with plenty of variation in the range. With any desktop cooler, air or AIO, being able to replace a likely-to-wear component like a fan should be child's play, shouldn't it?

The silicone cooler

Last month, a desktop arrived with a problem that wasn't particularly important, but as I seem to be talking about coolers this month it's worth a quick mention. The machine was a few years old and, again, built by a well-known manufacturer of bespoke gaming systems, utilising an unusual CPU cooler. Its retention bracket allowed for the fans to be mounted only above or below the heatsink, rather than at the side. System builders will squabble into the wee hours about the impact of fan alignment and airflow, but my puzzlement was that someone had stuck the fan at the bottom, then used clear bathroom silicone to affix it into position.

I suspect this was to stop the combined disrupters of gravity and couriers from dislodging it during transit, but the manufacturer's logistical spark of genius prevents the user from whipping off the cooler to replenish the CPU compound. I've fitted many thousands of CPU coolers, featuring wildly different locking mechanisms, plate attachments and wiring configurations. Guess how many of those required a caulk gun and bathroom sealant?

A cool CPU is vital in any build. AMD and Intel have radically improved the "stock" coolers they supply, but there are many instances

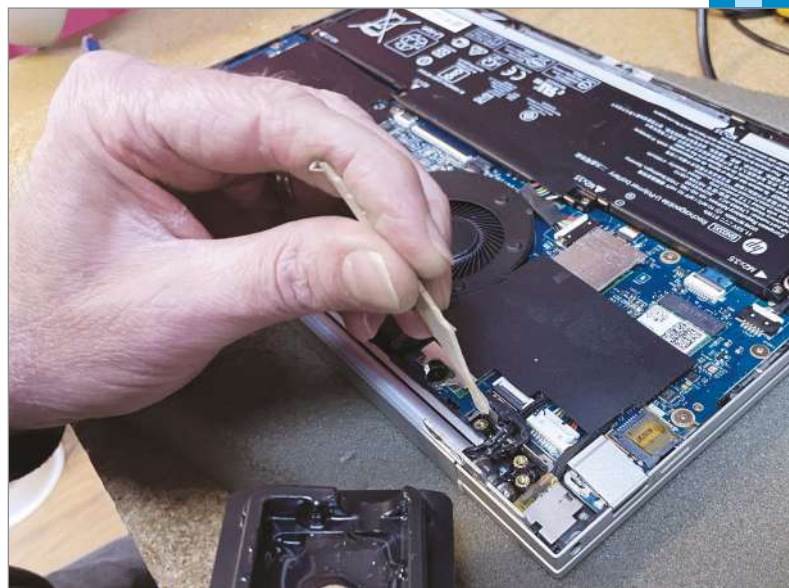
where third-party coolers are used for reasons we've already mentioned. Choose your cooler carefully and you should have many years of cool and quiet computing.

Mellow yellow

I've mentioned before that repair is much like the "sawing the woman in half" illusion. It doesn't really matter how the trick is done, but the audience will only be happy once the good lady is back in the universally accepted minimum and maximum number of pieces: one. I'm assured it's awfully hard to get applause from a crowd that's witnessed the assistant's leg rolling off into the wings.

In repair terms, I'm referring to laptops and the phenomenon of taking them apart but being utterly unable to put them back together. I've spoken before about dodgy plastics and my frustration at having to replace entire covers for the sake of a few dodgy screw-brasses. Even the strongest glues can't cope with the torsion forces in play when a laptop lid is opened. If the hinges have nothing to grip, then the only audible sound will be a disquieting splintering noise and some extremely rude words.

Over the past few months, I've been experimenting with a few willing customers to find a decent adhesive that remains held together many months down the line, and I'm pleased to say that I think I've found one. The current favourite of my 100% unofficial, non-scientific, non-affiliated set of experiments is J-B Weld's PlasticWeld ([tinyurl.com/360JBWeld](https://www.tinyurl.com/360JBWeld)), which is a two-part adhesive and epoxy filler system. As its name suggests, it's formulated for plastic repairs, and I've been



ABOVE Applying glue requires precision and skill – and a wooden fork from the chippy

"My hot glue tip is to apply a layer then let it cure for a few hours, then apply another layer"

impressed. The only quirk is that it's in a colour that J-B Weld has named "Translucent Yellow" but to me is more "Beachfront Public Toilets, Skegness, 1986".

One of the USPs of the PlasticWeld is that it sets in five minutes and cures within an hour. I didn't find that to be completely true, but then I've never owned a laptop where the battery has lasted over four hours, but this magazine is full of manufacturers that claim they do. Anyway, it works well if you take the Bob Ross approach and paint it on in layers.

My hot glue tip (but not hot-glue tip, which is something else) is to apply a layer then let it cure for a few hours, then apply another layer and repeat as required. As you can see from the photo above, craftsmanship like this requires skill and precision tooling, of which I have neither. That is indeed a repurposed wooden fork from the local chip shop, but it worked a treat on applying several layers of PlasticWeld. After three months, the laptop is still in one piece.

Sticky keys

As Steve Jobs said, "innovation is the ability to see change as an opportunity, not a threat". He was clearly predicting the Teclast ([teclast.com](https://www.teclast.com)) laptop which arrived in the shop last month. If you're a global brand, do you follow the masses, producing a range of keyboards to reflect the territories and languages in which they'll be sold and used, or do you innovate and differentiate?

Teclast had clearly decided to lead and not be led, so affixed stickers to the keyboard, which is something I hadn't seen since I tried to learn the piano when I was seven. Give it time and all the major brands will be at it, claiming it's more sustainable. Maybe.

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BELOW Silicone to cool the silicon





ROIS NITHUAMA

“Traditional security training never worked. It was not then and is not now fit for purpose”

Rois takes aim at patronising cybersecurity training software – and the companies behind them that seem to think we’re all three years old

Cybersecurity training is broken. Is it? Is it really, though? In line with the current trend to offer trigger warnings for almost everything, here’s yours. A highly uncontroversial difference of opinion will follow. If that doesn’t appal you, you’re one of my people, let’s get into this.

So here goes: cybersecurity training is not, in fact, broken. It’s worse than that.

For the statement “cybersecurity training is broken” to be true, it would mean that at some point in its short history that cybersecurity training had worked. I maintain throughout this article that the old-school traditional security training that we all know and loathe never worked. It was not then and is not now fit for purpose. I believe that businesses are wasting time and money. I think that the traditional training is so mind-numbingly tedious that it is having the opposite of the intended effect. Further, it’s contributing to the notion that cybersecurity or security training is for geeks, misfits and pedants and not for the business as a whole. And finally, that cybersecurity training is harder than splitting atoms with a butter knife.

I’ve written here before about the ham-fisted approach of using tantalising promises of bonuses in bait-and-switch corporate emails. This does nothing to improve the security of the business and everything to damage the trust and loyalty of the management that sanctions such actions. So while that’s part of the “olde worlde cybersecurity training”, I feel like we’ve been there before.

What’s really grinding my gears is the infantile, inane and idiotic security training programmes that



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“Cybersecurity training is not, in fact, broken. It’s worse than that”

staff all around the globe must endure. How do I loathe it? Let me count the ways.

1 Peppa Pig-style characters

Am I three years old? No. No I am not. Is your workforce made up of toddlers? Well, unless you’re operating an illegal sweatshop for minors, then probably not. I get the selling point, they want to make learning fun. But I’m not sure infantilising your workforce and requiring them to watch two-dimensional characters omit to lock a window is really the message you want to be landing with them. Saying “you’re brighter, smarter and more productive than our competition, we’ve selected you carefully and your time has value to this firm” is – oh, I don’t know – just a better corporate message for your teams. Treating them like adults says all of the above without saying all of the above.

While I decry the two-dimensional characters, there is a benefit to them. It allows me to highlight the lack of breadth and depth, not only in the childish imagery chosen by these overpriced providers of so-called

training, but also in the content as a whole. If only every segue were as smooth. Bah-dum-tish.

2 The training content

If the visuals that accompany the training don’t make your teeth itch, how about the content?

This particular bugbear is a two-parter. First, when clients have asked me to evaluate training programmes they’re considering, I’ve consistently found errors and logical inconsistencies in every one I’ve reviewed. Trouble with this is that it’s Rubbish In: Rubbish Out and now you’ve essentially infected your workforce with bad information.

You’ll recognise the other bit if you’ve ever been required to participate in the absurd setups that these security training programmes compel you to sit through. You have the 2D character walking around a building. The character has an option to close the door or leave it wide open.

Do you close the door behind you and watch for tailgaters? Or do you say, “come right in, stranger”? You truly are on the horns of a dilemma. If you spot someone you don’t recognise, they’re not wearing a lanyard and are unaccompanied, there is in a “Pascal’s wager kind of way” no downside to assuming the worst. There. If you omit the bit about Pascal, you can get all that into your head in under nine seconds. Don’t make me come back and test you on this next year.

But why favour efficiency when you can torture busy people by drawing out a bloated animated scenario that the user cannot fast-forward? That’s right: introducing issue number 3.



RIGHT The perfect training material – for toddlers

3 Time crisis

Time is money. When a business tolerates lots of meetings with no agenda or output, pursues strategies that are untested or rolls out training that prohibits the user from skipping to the question, it is in my view a waste of the subscription fee to the programme, a waste of company time and a waste of corporate treasure. There, I said it.

But just so I'm clear, devoting time to continual professional development is, I believe, time *and* money well spent. But disabling a grown man or woman's ability to skip through an elementary scenario to a test that a primary school child could pass is a waste of resources.

There's one simple trick to accelerating this whole process and saving time, money and goodwill. Remove that excruciating time lock that prohibits the worker from being able to go straight to the test. In fact, what am I thinking, here's a radical idea: why not just start with the test? If the user passes the test, skip the training.

Security training that's designed more to test your patience than your knowledge, isn't, at the risk of repeating myself, fit for purpose. If training was really doing the job it claimed, there is no way that people would be undertaking the same or similar training on a loop, year in, year out, like you're captured in some hellish Groundhog Security Training Day.

We've all studied and passed tests, whether it's school, on-the-job training or driving. While we may need to refresh our memories on details, we rarely (if ever) have to undertake the same training every year. Never mind retaking the test. Just to flesh out the details for this, and to give this point some context, according to official statistics, in the UK in 2022 nearly 30,000 people were killed or seriously injured on the roads. But only those who are demonstrably poor at driving need to retake the training and the test. So why is security training being positioned as more difficult for Joe Public than operating a machine that can kill or maim people? We're allowed to assume that people are smarter than this training presumes them to be. Or, in the alternative, not so oxygen-deprived that they can't be trusted to remember to close a door behind them without annual training.

While my trash talk about rubbish content sounds bad, I promise you it's only going to get worse.

Cybersecurity training + GenAI

Recently, following a request from a client, I attended a meeting to evaluate a proposed alternative to its current security training provider. While I have made a decent case for not deploying traditional security training, replacing like-for-like with like-for-less helps no-one. So what was it like?

On the face of it, the firm presented the material in a more sophisticated way, providing access to large amounts of information. Because of the enormity of the task of reviewing the library content, I wasn't prepared to check its homework. To accelerate the process, I needed to know the source of the content to ensure its credibility and that it could be audited, plus how frequently the firm updated its information. Did it, for example, have push notifications for changes to the course material?

Not only was the firm unable to answer the question during the meeting, it was unable to supply the information after weeks of chasing. Instead, framed in my office on the wall of shame I have a copy of an email from someone in that firm taking aim at my "academic" approach. Given that we were discussing training material, that's not the burn he thinks it is. Checking the sources for sense is imperative because the last thing any business needs is course material thrown together by generative AI. We don't need more content, we need credible, pertinent content.



ABOVE Treat your workers like children and they'll behave like them

"We don't need more content, we need credible, pertinent content"

BELOW Security training can test your patience more than your knowledge



NIS2 requirements

There's a lot of legislation that will require management bodies to gain and maintain sufficient up-to-date knowledge to assume responsibility for the firm's cybersecurity risk management measures. The long-standing "training" programmes in the security field have never and will never provide executives with the substantial knowledge required to meet their burdensome legal obligations.

But if there is some light at the end of this tunnel, it is this. The entities that fall within the scope will need to make available to their workforce "similar training" that the executives undergo. And this is where the really interesting material resides. It's not just shutting that door, it's learning about risk management measures that can be applied in lots of areas because the fundamental principles are the same. This is where the interesting material lives, and it's only useful and of value to firms if it's up to date and clearly referenced.

And breathe...

It's not before time that we kick security training providers who treat the workforce as if they're dumber than a box of rocks to the kerb. There is room for new firms that take security training seriously to emerge. These new firms will need to use effective interventions for the right people at the right time and not treat the workforce like they've just graduated from nursery school.

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DAVEY WINDER

“It’s like logging in with your username, password and a 2FA code but on steroids”

Davey Winder is still banging on about authentication and you can’t stop him – but fortunately Microsoft and Google both agree

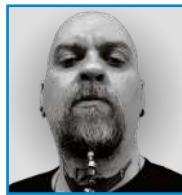
I know it seems like I’m a one-trick pony right now, with that truck being authentication technology, but it’s such an important part of any security posturing that I’m in no mood to apologise for it.

So, following on from last month when I covered recent moves to require email authentication in the form of Domain-based Message Authentication, Reporting and Conformance (DMARC) by Google and others to crack down on spam and the malicious content it often leads to, I’m back on the authentication soapbox again. It would appear that some of the biggest names in tech are finally taking your security seriously without having to release a disclosure about how it was breached and your personal information compromised.

The deprecation of the username and password login

Google and Microsoft are turning their attention to login security and, in particular, what they refer to as basic authentication, and everyone else calls your username and password. The deprecation of something that is about as basic a method of user authentication as can be is a big deal.

I’m fed up with being “that guy” who bangs on about mandatory two-factor authentication being a bare minimum requirement for any access to accounts in 2024 (and 2023, 2022, etc), with there always seemingly a counterargument of usability and user patience made in return. Let’s face it: with passkeys now something everyone can start using, and finding they not only make access more secure but less complicated as well, that counterargument should be shot to the ground. Passkeys play a part in the moves being made towards



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“I’m fed up with being ‘that guy’ who bangs on about mandatory 2FA”

“modern authentication”, so let’s quickly get the technical explanation out of the way for those at the back.

According to the Fast Identity Online (FIDO) Alliance, which produces an open specification for user authentication technologies, passkeys are “a replacement for passwords that provide faster, easier, and more secure sign-ins to websites and apps across a user’s devices”. They work by creating a cryptographic key pair bound to a service domain during the user registration process. The private key remains exactly that on your device, while the public key is registered with the online service you are authenticating to.

Cryptographic key pairs are complex beasts, way more so than most passwords, and are unique to each service. When you sign in to an account using a passkey, you need to prove that you’re in possession of the correct private key by way of a challenge-response from your device and the service itself (which never sees or stores it). This can be done by the user with a fingerprint or facial scan on their phone, a PIN on the device storing the private key or by way of a physical security key.

FIDO says that “the protocols do not provide information that can be used by different online services to collaborate and track a user across the services. Biometric information, if used, never leaves the user’s device.” Think of it as being like logging in with your username, password and a 2FA code but on steroids as far as the security implications are concerned.

Google Workspace kicks less secure apps to the kerb

What are Google and Microsoft doing to force better authentication methodology onto users? Let’s start with Google, which has announced that it’s ending access from “less secure apps, third-party apps, or devices” to Google Accounts from 30 September 2024.

Google has been talking about kicking basic authentication to the kerb for the longest time; I believe it was first mentioned back in 2019. But an email to Google Workspace admins in January and an earlier support posting (tinyurl.com/360workspace) have made it clear that the time is now. “As part of our commitment to user safety, Google Workspace will no longer support the sign-in method for third-party apps or devices that require users to share their Google username and password,” the company confirmed.

The replacement authentication will be “Sign-in with Google”, which Google says is “a safer and more secure way to sync your email to other apps”. All of which means that come October, any app or device without the Sign-in with Google option will return errors such as invalid username or password when trying to access Calendar, Contacts or Gmail data.



RIGHT 2FA has been the bare minimum security requirement for some time now

It also means you need to get your Google Workspace house in order as an admin and end user.

If you are such an admin then you should have already noticed that Google removed the Less Secure Apps (LSAs) settings from the Google Workspace Admin Console, which happened on 15 June. While already-enabled users will still be able to connect until the September deadline, disabled users won't be able to access LSAs. Google confirms that this "includes all third-party apps that require password-only access to Gmail, Google Calendar, Contacts via protocols such as CalDAV, CardDAV, IMAP, SMTP and POP". Talking of which, IMAP enable/disable settings were also removed from users' Gmail settings from 15 June.

The bigger changes happen at the end of September, after which CalDAV, CardDAV, IMAP, POP and Google Sync will no longer work when signing in with just your password. Yep, that's right, Google Sync is being sunsetted, as Google calls it. This, says Google, is because it "doesn't support OAuth authentication, 2-factor authentication or security keys".

Using Microsoft Exchange ActiveSync to enable users to synchronise their mail, contacts and calendars to platform-specific and third-party apps on their mobile devices, Google Sync remains a reality for many people despite the less-than-great security aspects. No more using sign-in with Microsoft Exchange to bring Gmail messages into Apple Mail on your iPhone, in other words.

From the June deadline, new users will have been unable to connect to Google Workspace via Google Sync, and from October existing users get added to the *verboden* list. Google has offered advice for admins to transition your business away from Google Sync, and I recommend you tackle this sooner rather than later for obvious reasons.

Google recommends you check which devices in your organisation use Google Sync from the Google

Admin console, by way of Devices | Mobile & Endpoints | Devices, and filter by Type: Google Sync.

Unsurprisingly, Google also recommends you switch to Google apps such as Gmail, although configuring app management settings to allow data syncing for specific apps is an option many may well prefer if those apps support Sign-in with Google. If your users want to continue using iOS apps, then it's worth visiting the Google support document (tinyurl.com/36oapplemail) as it goes into step-by-step detail to make the transition as smooth as possible. Google makes it clear, as it should, that the transition should be tested on a small number of users first, before rolling it out across the entire organisation. Hence, there's a pressing need to deal with this now rather than leaving it in the laters pile.

Microsoft introduces more secure Outlook email syncing

As for Microsoft, let's start with what's already happened. As from July, anyone wishing to use the "left rail" at Outlook.com to access their Gmail accounts will be out of luck. You'll need to switch to using the Android, iOS or Outlook for Windows or Mac applications instead. This is just one of a bunch of new requirements being implemented by Microsoft to ensure Outlook users are best aligned with the Secure Future Initiative (tinyurl.com/36ooutlook) bringing security by design, default and operation to Microsoft products.

The Microsoft announcement comes by way of an official posting, "Keeping our Outlook personal email users safe: reinforcing our commitment to security" (tinyurl.com/36opersonal), in which Microsoft Tech Community



ABOVE Outlook.com users will also have to move to modern authentication

"There's a pressing need to deal with this now rather than leaving it in the laters pile"

BELOW Google Sync will no longer work after September

employee David Los explains how and why basic authentication is being deprecated for Outlook users.

The "why" is simple enough, and essentially the same as with Google: "Email-based cyberattacks have only increased with time, so we are requiring modern authentication for all Outlook customers to better help protect their personal accounts." The "how" involves the deprecation of personal Outlook logins that use a username and password for authentication, the deprecation of the light version of the Outlook Web application, and the end of support for the

Mail and Calendar apps.

If you don't use better authentication methods then, starting on 16 September, "Outlook will require that all those with a Microsoft email account use a mail or calendar app or the Outlook.com website which supports modern auth, such as the latest versions of Outlook, Apple Mail or Thunderbird." You will no longer be able to access your Outlook.com, Hotmail or Live.com email from less secure applications. If you use the light version of the Outlook web application, the deadline for deprecation comes a little earlier: 19 August.

Like Google, Microsoft has published guidelines (tinyurl.com/36oguidelines) to help users transition away from basic to modern authentication and be able to continue syncing Outlook Email in non-Microsoft email apps. It warns that, until 16 September, users signing into Outlook.com with just their username and password could experience "recurring password prompts in Outlook and other third-party email applications".

Outlook for Windows supports modern authentication in all current Microsoft 365 subscription SKUs and Outlook 2021 LTSC (any SKU with build 11601.10000 or higher) when connecting directly as Outlook.com. "If your Outlook is configured to connect to Outlook.com using POP or IMAP," Microsoft says, "modern authentication is not supported", so after the September deadline it will no longer connect. In which case,



Starting in Fall of 2024, Google Workspace accounts will no longer support Google Sync. For exact dates, visit [Google Workspace Updates](#). You should [transition your organization off Google Sync](#). To check which devices in your organization use Google Sync, in your Google Admin console, go to **Devices > Mobile & Endpoints > Devices**. At the top of the page, click + **Add a filter** and select **Type > Google Sync**.



Continued from previous page

Microsoft recommends getting a newer Outlook app that does support it and set up using Outlook.com Sync. “You can either purchase a new Outlook licence, use the Outlook that is included in your Microsoft 365 subscription, or download Outlook for Windows for free,” Microsoft advises.

Alternatively, you can create a new Outlook Desktop profile and add your Outlook.com account using automatic account configuration, and this brings modern authentication along for the ride. Do this instead of using POP/IMAP and SMTP. It should be noted that the following versions of Outlook Desktop don’t support modern authentication for Outlook.com: Outlook 2007, Outlook 2010, Outlook 2013, Outlook 2016 MSI, Outlook 2019 LTSC and any release of Outlook Desktop with a version less than 11601.10000.

Apple Mail users syncing with Outlook email shouldn’t be impacted by the changes being made by Microsoft as the app supports modern authentication by default. However, Microsoft notes that some users may have their accounts configured to use basic authentication instead. In which case they are likely to be seeing password prompts or connection errors. To fix this, you’re advised to remove and then re-add the account as Outlook.com under Settings | Mail | Accounts.

And finally...

Apple iOS 18 will be bringing a dedicated, default, Apple password manager app to the iPhone security party. Named Passwords, in typical Apple fashion, it will also be available for iPad and Mac users. I’m looking forward to discovering how well this stands up to some stiff competition, not least 1Password, which has been the go-to for Apple users (including me) for a long time, and Proton Pass, which is also now available on iOS and macOS.

Syncing across devices using iCloud, Passwords promises to support Windows PCs and features everything you’d expect from a modern password manager. I’ll report back once I’ve had a chance to do some real-world testing.

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STEVE CASSIDY

“Smaller networks are where an experienced engineer is most needed, and least likely to happen”

How to turn your speedy laptop into a slow-moving fossil, plus why small businesses should sometimes think big and old when it comes to servers

I’m shocked to report that for the first time ever, I’ve been accused of overkill. As regular readers will know, I have a distinct preference for older, ex-corporate grade servers over the expensive servers that are presented as being “just right for the job”. Mostly this comes from casting a jaundiced eye over the warranties you can expect from the server companies, plus a trail of projects in which I was parachuted in when either the small print, or the man-in-a-van, didn’t quite meet the customer’s expectations.

The commonly held view is that a small business server has a much lower priority for repairs than a big-company machine. Large companies pay real money for 24-hour service, although even here the small print can bite back: some 24-hour contracts say you can report the fault 24/7, but the actual human engineers only work nine to five. Small companies live under a strange delusion that the manufacturer will put everything back exactly the way it was before the Bad Thing happened, for no money, at a transfinite rate of data recovery and with the reloading of patches, apps, databases and so on.

Naturally, it’s the big businesses that have the spare resources and the clever server-management control suites to make a dead server into an almost total non-event. That means they actually don’t need the fancy attendance contracts; at the top of the size range, almost everyone is on virtual servers now, and provided your VMs are kept on separate hardware from your compute nodes (the way modern data centres are built), flipping from a dead CPU to a live one is a matter of a few



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“He brought in a whole new category of doubt – that of being too big”

BELOW The Fujitsu servers were deemed to be ‘overkill’

mouse-clicks and a slightly nerve-wracking disk integrity check process.

But this is definitely not guaranteed to work in a smaller network, even if you have spare, correctly sized servers stacked up in the shed, ready and waiting. Smaller networks are where the presence of an experienced engineer for a crash diagnosis process and subsequent decisions over what to restore, rebuild or reload is most sorely needed, and also least likely to actually happen.

If company size isn’t the sole factor influencing warranties, as the industry believes, what other flawed assumptions might be lying in wait to trip up even experienced IT professionals? Well, that brings me back to the start of this article when I was accused of overkill.

I was giving a new-ish contractor a tour of my remote, mountainous country client. He was most proud and pleased that the main VM host in his company’s network had gone all the way through the pandemic lockdown without any major hiccups or loss of service. His face was a sight to see when he was shown the server nook in one corner of the office, and he spotted two large Fujitsu upright servers, each emitting a low moan

of slow-turning fans the size of dinner plates. “These are a bit big for the job,” was his instant verdict. Ironic, really, because the main reason for dropping the previous supplier was that it kept complaining of terrible slowness in database access. Not only was his software better, he claimed, but he brought in a whole new category of doubt – that of being “too big”.

Naturally, I disagreed with his line of questioning. I suppose I might have made more money if I had stuck religiously to the market’s buying recommendations. After all, when things fail I



get The Call. For example, one server array drive member failed a couple of generations of servers ago, and the process left us with a USB hard drive whose volume label is “SF10,000”, that being how much the recovered data it held cost the business. We need such reminders of the way that small-business servers announce a malfunction (and proceed to become unavailable) to emphasise the value of your data versus the cost of presenting it to your workforce.

This was by no means a case limited to snowy mountaintops. In the same year, another client forlornly asked me to disembowel its noble but ancient Compaq server, taking out the drives with unhappy red LEDs on their cage slots.

Having obliged, I started the process of looking for replacements, and while writing down all the part numbers off the physical drives themselves, I came across a faded Sharpie pen scribble on one of the dead drives: a date. When someone had put this drive into service, they had the foresight to write down a starting date on the drive itself. Based on this bit of inky scribble, I could see that the drive had run for one month short of a complete year, before giving up the ghost. That’s by direct contrast with the Fujitsus, which had sat in the office, turned on and doing work, right through lockdown: 11 months versus getting on for four years, with a couple of years extra on one box to get to a grand total of six years.

My clients all felt that extra money on more reliable drives was definitely well spent, so the impromptu lecture on the “too big hardware” was immediately bounced back at the new contractor. What kind of “rightness” did he think he was serving here, anyway? Was it his view that it was only right and proper for small businesses to suffer prolonged server downtime?

I knew I’d lent a trifle heavily on the sarcasm when the software guy started to blather and bluster about industry practice, and how components manufactured in vast numbers had all been benchmarked by Google, whose technical prowess was sufficient to brush aside any other rationale.

I have a stock reply when people take “the Google position” in these discussions, which explains how much of the hosting centre environment, the data formats, the networking, the server specifications and the drive architectures



are modifiable from the assumed “normal” at the whim of the product designer. Where’s the little “turn it up/turn it down” icon on Gmail when I seem to be having a slow day? It’s not there, so don’t go looking.

To say that his thinking was somewhat bent out of shape would be a mild understatement. He was treating the proposed deployment and lifespan of a bottom-spec server as close to the rule of law, as if smaller companies were not merely served well by just one box, but that attempts to break out of such thinking ought to be grounds for instant dismissal.

The Google argument worked nicely for me here again – sure, but it doesn’t let you scale up or down, or decide how much resource you want to consume today – but my main argument is that by using its own selection of platform and hardware, the smaller user can and indeed should use the largest planet-spanning infrastructure deployment in the history of mankind.

In this case, I used simple economics. I pointed out how much each server had cost – well under

ABOVE How big is too big in the server room?

“I was trying to keep things all-knowing and competent, which lasted five seconds”

BELOW The Lenovo Yoga Slim 7i – I’ve got one of those!

£1,000 before the disk arrays were added, on original list prices that in one case was far over £15,000 – and explained not only were they far more reliable than the proposed single server but also far cheaper.

Ooh, I’ve got one of those!

You know how sometimes the little boy will slip past your safeguards? The phrase, “Ooh, I’ve got one of those,” that is. There I was in a first meeting with a new client, a young lady with a bitter litany of complaints about poor performance from her relatively new laptop.

I was trying to keep things suave, all-knowing and competent, which lasted for five seconds as she yanked out of her bag the offending device: a Lenovo Yoga Slim 7i. Exactly the same as the one in my pack, tucked under our meeting room table.

I couldn’t stop myself. I’ve used the Yoga for long enough to comprehend its speed, be that in games or regular business use. The slimness and the zippiness conspire together to deliver a somewhat old-school five-hour battery life, but I thought the performance trade-off well worth that small sacrifice – and with USB-C as the only charging connection, the short battery life is further excused by even shorter charging times.

But not for my new client. She had a smaller SSD than mine, with the same edition of Windows 11 installed and garlanded with all that Lenovo bloatware. The disk was packed full of her work data, and I asked if I could delicately wander around the folder tree

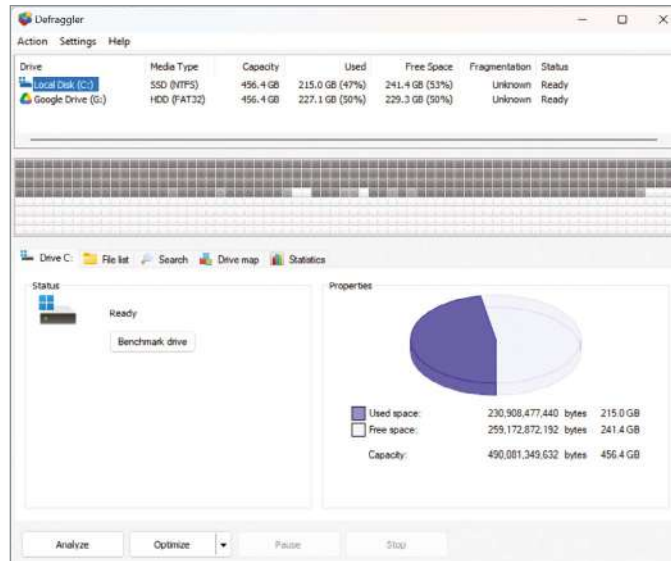


to see if anything jumped right out at me. Wrong idea! Her data was confidential, and her customers' data even more so. The paperwork, should my enquiring eye fall on the wrong snippet, would be unimaginably tedious. Can't I look at, say, a map of the disk or something?

Actually, I could. There's a whole world of small utility programs that diagram your storage as a lot of little squares, variously coloured to indicate size, fragmentation status, age or whatever else you might be able to think up. We had a short tussle about the provenance of PC utilities available for free download and she settled on Defraggler (available from ccleaner.com/defraggler) as a reasonably harmless and non-disclosive compromise. Right enough, the Defraggler analysis run revealed an SSD with hardly any unconsumed white space sectors left at all. Not only was it low on empty sectors; the centre of the diagram was a sea of nasty, red blotches, showing where larger files had occupied space taken from the deleted corpses of several much smaller and earlier files.

That explained the lack of applied updates, I said instantly, only to get an eyebrow cocked at me as a potentially dangerous, unhinged old fool. Everybody knows, I was told, that defragmentation is a moonshine piece of nonsense, long since superseded by on-disk file systems built cleverly to render the whole notion of fragmentation obsolete. So, this wasn't a straight repair request; it was more like validating a series of religious edicts, all of which ended with my comment "and yet your machine runs like a dog".

I persisted, mainly because I had chased down my own Yoga Slim out of curiosity last year. The new tranche of laptops seemed almost indecently rapid, whizzing through operations we all expect to require the spinner to entertain us for a few seconds. Initially this had been a marker of machines using the new generation of AMD Ryzen CPUs, but faint signs of a fightback by Intel could be seen. The point being that I already knew that my machine was pretty fast. What I hungered for – and this was why I put up with the



edict-driven fault diagnosis and requirement to not even wink while a document might be visible, lest I make out something deemed confidential – was a broken machine to evaluate.

Which showed me some rather depressing, but perfectly clear, findings. One easy way to make a machine new in 2024 as slow as one in use since 1997 is to fill up its SSD with mid-sized files. For example, the output of half a dozen catalogue shots.

I said nothing should be done with that machine until all the work output had been copied to a non-rubbish form of backup storage and (join me in blaming the imp of the perverse here) I pushed the boat out and said that given the apparent value and confidentiality of the files, I'd rather see them on a sensibly specified iSCSI target box than scattered everywhere round the office on direct-connect USB keys.

Right enough, this proposal was met with a sneer. Everyone apparently knows that iSCSI is hardly ever used for this type of thing because Apple doesn't like iSCSI as a disk service, and has left the market of third-party initiators to anonymous Russian dev teams, who as any fool knows are just there to steal all your data.

ABOVE Defraggler analysis can reveal the source of a problem

"This wasn't a straight repair request; it was more like validating a series of religious edicts"



LEFT The new tranche of Yoga Slim laptops are almost indecently rapid

So, time being short, I just stood up a small NAS as a target and put several different types of backup on it, nested one inside the other like Matryoshka dolls. First, the boot partition and the operating system; then any apps or app installers I could find (it didn't look especially hard because I didn't intend to overwrite the small SSD once the backups were deployed); and finally the scattered and cryptically named working folders. Then I hit the disk with an overnight mains-powered defragmentation utility.

Of course, this engendered a complaint about "having work to do", to which my failing patience responded by crisply pointing out that the longer it takes to complete – especially on solid-state storage – the more desperately it's needed. Almost by magic, the following morning, several Windows Updates had crept in and installed themselves, as soon as they could reserve a big enough lump of contiguous storage to actually do their thing. I can remember Pentium laptops displaying this particular mix of slowdown and update boycott before the turn of the millennium; to find it can be induced on new laptops such as the Yoga Slim is a disappointment, to put it mildly.

Right now, this project is idling, waiting for several aspects to be resolved. I want my blood pressure to drop a few mmHg; the barrage of urban-myth and conspiracy-theory IT stories is going to have to fade out of memory before I can dive back in, refutations at the ready. We also ordered a 2TB NVMe SSD to replace the Yoga's 512GB original boot disk.

However, oddly enough, her new drive may be superfluous. Being forced to work with the 6TB iSCSI target volume presented by the NAS box may be the biggest win from this whole misinformation-heavy, paranoid doubting encounter; my new client has realised it's often quicker down the humble Ethernet line than it is off the beleaguered and much assaulted internal boot SSD. I wonder how many other people could avoid this kind of nail-chewing neurosis by taking all the support fairy tales about their various devices, and making a nice warm bonfire out of the whole lot?

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RETRO

Inspirational stories from computing's long-distant past

Netscape Navigator: fast lane to success

The World Wide Web was initially slow and clunky, but Netscape sped forward with a ground-breaking browser which, as **David Crookes** explains, blindsided most of Silicon Valley

If you ever used Netscape Navigator in the early days of the World Wide Web, then your memory likely comprises two things: the sight of comets falling to earth around the "N" of the Netscape logo as web pages loaded, and the fact that you'd be staring at them for ages, watching your life slowly ebb by, given the slow nature of internet connections in the mid-1990s.

I was reminded of this when noting that the first version of this iconic browser is almost 30 years old, prompting me to seek out the animation once more. Turns out there's an add-on for Firefox that replicates it called Firescape Navigator (tinyurl.com/36ofirescape), and there are videos on YouTube providing minutes of nostalgic "fun".

It also became apparent that the animation didn't actually appear with version 1.0 (which had a solid purple N set against a static background) but arrived with 1.1. And, if we're being really pedantic, Netscape Navigator's history stretches back to 1993, marking the beginning of an innovative app that not only made the web easier to use but proved to be so disruptive it helped to shape the future of Silicon Valley.

Not bad for a company created almost as a form of revenge. It was established by James H Clark, who had previously founded a high-performance computing manufacturer called Silicon Graphics. Clark had become frustrated when, as reported in *Wired* magazine in 1994, it appeared that he was being viewed "less like a visionary than as an eccentric uncle – tolerated, but not taken very seriously."

Silicon Graphics had gone public in 1986, making Clark a millionaire, and despite the firm going from strength to strength, much credit was being given to the person he'd hired to be its CEO, Ed McCracken. Clark's control over the company declined over the years and it culminated in him quitting during a board meeting. From that point on, as stated in Michael Lewis' excellent book, *The New Thing: A Silicon Valley Story*, "Clark was intent on inventing a new role for himself".

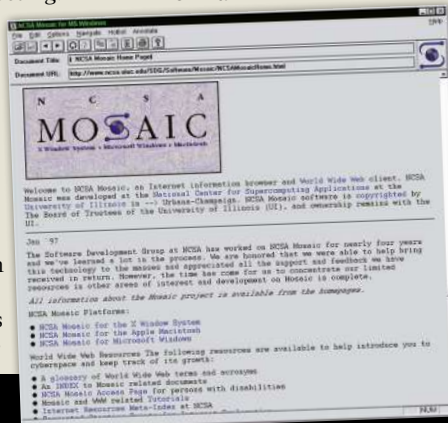
TV times

There was a determination to show that he was responsible for the success of Silicon Graphics, whose

ABOVE The battle between Netscape Navigator and Internet Explorer was fierce

"Clark was being viewed 'less like a visionary than as an eccentric uncle – tolerated, but not taken very seriously'"

BELOW Version 1.0 of the NCSA Mosaic browser, by Marc Andreessen and Eric Bina



workstations included the world's first 64-bit workstation in 1992; you can see the machines in the 1993 movie *Jurassic Park*. To that end, he wanted to create a fresh company that would "invent the future" and make him at least \$100 million. Trouble is, Clark wasn't quite sure what the business would do.

One idea was to develop software for so-called telecomputers. Clark had written a paper (tinyurl.com/36otelecomputer) in which he said such a machine would "bridge the gap between television and multi-media computing". He said its central role would be to deliver entertainment but also allow for media-rich textbooks, media retrieval from databases and libraries, media mail, video telephones and more. He believed it would address the issue of 95% of Americans owning a TV but only 10% owning a computer.

Lots of companies tried to create a telecomputer and, in 1993, the *New York Times* (tinyurl.com/360timewarner) reported that cable TV company Time Warner was in discussions with Silicon Graphics "to develop computer gear for the interactive television networks that are expected to revolutionise home entertainment".

To help him produce the software, Clark got in touch with a 22-year-old University of Illinois graduate called Marc Andreessen who, as part of the National Center for Supercomputing Applications (NCSA) group, had developed a web browser called Mosaic. Working with Eric Bina, Andreessen's app was easy to run. It automatically displayed images with text and borrowed user-friendly elements from previous browsers such as buttons and bookmarks.

The browser was proving to be a hit. "Before Mosaic, finding information on computer databases scattered around the world required knowing – and accurately typing – arcane addresses and commands like 'Telnet 192.100.81.100'," reported the *New York Times* in December 1993 (tinyurl.com/36onyt).

"Mosaic lets computer users simply click a mouse on words or images on their computer screen to summon text, sound and images from many of the hundreds of databases on the Internet that have been configured to work with Mosaic." If Andreessen was able to create such a great app, Clark surmised, he'd be a good fit for his new venture.

■ Piecing together

Thing is, though, having discussed applications for the expected telecomputers at great length, Clark suddenly announced he wanted to call a halt. As Lewis' book (published in 1999, making it a near-contemporary account) recalls, Clark reckoned the telecomputer would be too expensive and ahead of its time.

Andreessen suggested building a Mosaic killer instead, and he laid out his reasoning. In December 1993, more than 5,000 copies of the browser were being downloaded each month, but the number of people using the internet was rising substantially. Clark could see the potential.

That said, in truth, doubts were being cast over such numbers. Andreessen told Clark that 25 million people were using the internet – citing a well-known figure at that time – and he claimed that the numbers were doubling annually. Yet in 1994, an internet demographer called John S Quarterman (again reported in the *New York Times*, tinyurl.com/36oquarterman) suggested the figure was too high and that there were perhaps two or three million users instead.

Even so, Clark listened to Andreessen and agreed. He asked Andreessen to hire his college friends – Eric Bina among them –

and Clark created a company called the Mosaic Communications Corporation, which offered the Mosaic browser killer – named Mosaic Netscape – for free to individual, academic and research users.

As laid out in the press release on 13 October 1994, this decision built "on the tradition of software products being offered free of charge". Vice-president of technology, Andreessen, said it was the company's way of "contributing to the explosive growth of innovative information applications on global networks" and he reckoned it would lead to greater interest in the internet, widening the overall user base.

It was certainly an impressive application. Released in public beta for Windows, Mac OS and X Window System, it offered encryption, server authentication and the promise of being able to take advantage of online publications, financial services and interactive shopping. It was also optimised to run smoothly over 14.4K modems, delivered performance at least ten times faster than that of other browsers and boasted native support for JPEGs.

"There were many exciting new features," said Pär Lannerö, who has created an online Netscape browser emulator at dejavu.org. Netscape introduced background images, for instance, "so we didn't have to have grey background everywhere" and it created text alignment options, "such as the <center> element (later made obsolete by CSS)."

The browser also introduced the <blink> element ("a very bad idea, but still a sign of innovation and development", Lannerö said), and it supported partially transparent images, "making it possible to do creative non-rectangular layout", he explained.



ABOVE Netscape Navigator 3 running GeoCities, via the emulator site oldweb.today

The browser also made performance improvements such as the ability to simultaneously load several images ("remember, this was the time of slow modems, so we literally had to wait minutes for some pages to load", Lannerö said). And, thanks to Lou Montulli, there were cookies, with the Netscape coder having figured as early

as 1994 that text files could be used to store easily retrievable information.

■ Information superhighway

By 15 December 1994, Netscape was out of beta and, within just four months of its release, it had gained the largest slice of the fledgling browser market. A decision was made to ditch the Mosaic name so as not to upset NCSA. Instead, the browser became known as Netscape Navigator, and the company was renamed Netscape Communications Corporation.

"It offered encryption, server authentication and the promise of being able to take advantage of online publications, financial services and interactive shopping"

To generate cash, commercial users were encouraged to snap up licences for \$99 per user (less for multiple user licences).

"This pricing strategy was a very important factor in Netscape's enormous success," Lannerö says. In fact, it was so successful that, within 18 months, it was turning its engineers into millionaires. As Lewis points out, it was 12 years before people were talking about Microsoft millionaires. By comparison, Netscape's growth was on steroids.

Clark and Andreessen's decision to focus the business on a browser shook Silicon Valley. Companies began to ditch plans for a telecomputer,

BELOW The first commercial web browser, released in 1994



realising that internet-connected PCs rather than televisions were actually the way forward. The situation came to a head on 26 May 1995, when Microsoft CEO Bill Gates realised his company would have to play catch up. He wrote a memo suggesting that “developments on the Internet over the next several years will set the course of our industry for a long time to come”. It proved to be pivotal.

“I assign the Internet the highest level of importance”, Gates wrote, adding: “The Internet is the most important single development to come along since the IBM PC was introduced in 1981.” He bemoaned not seeing “a single Word .DOC, AVI file, Windows .EXE (other than content viewers) or other Microsoft file format” online. Crucially, he named Netscape “a new competitor ‘born’ on the Internet”.

“Their browser is dominant,” he wrote, “with 70% usage share, allowing them to determine which network extensions will catch on. They are pursuing a multi-platform strategy where they move the key API into the client to commoditise the underlying operating system.

“They have attracted a number of public network operators to use their platform to offer information and directory services. We have to match and beat their offerings including working with MCI, newspapers, and others who are considering their products.”

Gates was determined to dominate the internet and Clark knew it was only a matter of time before Microsoft made inroads. Even so, Netscape continued to innovate. “In the steady stream of new beta versions they added Java support, LiveScript (today known as JavaScript), a plug-in API and encryption technology (SSL) enabling secure transactions over the internet,” Lannerö said.

“Because it brought us all of these new features, it gave users a sense of experiencing a rapid and significant technological development that obviously would have a great impact on society as well, thanks to how it transformed almost anybody into a publishing house and connected people globally.”

As a result of such activity and a solid user base, Netscape was in a position to be publicly floated. It had already attracted lots of venture capitalist investment – including John Doerr of the blue chip company Kleiner, Perkins, Caufield & Byers, who bought a 15% stake – but it went public after 18 months despite making losses. This went against the norm, which was to float only once there had been four consecutive profitable quarters, but Netscape placed five

million shares of its stock on NASDAQ on 9 August 1995 at \$28 per share.

The stock opened at \$71 per share, rose to a high of \$74.75 and settled to \$58.25 by the end of the day. According to the *Wall Street Journal*, Netscape Communications rose to a market value of \$2.7 billion within a minute – a valuation that had taken General Dynamics 43 years to achieve. Clark himself was worth \$566 million at the close of trading and Andreessen’s stake was worth close to \$59 million. Silicon Valley realised that profits didn’t matter so long as it was evident a company was growing rapidly.

“Having a past actually counted against a company, for a past was a record and a record was a sign of a company’s limitations,” Lewis wrote. The success of Netscape (the company) was also a wake-up to scores of engineers in Silicon Valley. Many had been reluctant to leave secure, well-paid jobs to work for unproven startups, but with the potential to make millions if they were to take a risk with the right fledgling venture they became more likely to gamble – so long as they got decent stock.

Browser wars

By the end of 1995, Netscape and Microsoft were embroiled in a browser war. Gates had ordered the development of a rival browser that would be bundled with some versions of its Windows 95 operating system, and Clark knew Netscape was likely to falter.

Lewis pointed out that Microsoft had a monopoly in the operating system market and that it had vast sums of money to invest in fresh development. Companies such as Netscape relied on Microsoft granting access to early versions of Windows to ensure software compatibility. The release of Internet Explorer – also based on the Mosaic source code – changed everything once more.

It took a while for Internet Explorer to resonate with users. The first couple of versions were relatively poor. “They lagged behind Netscape in terms of features and innovation,” Lannerö said. But improvements came thick and fast thereafter. “Version three of Internet Explorer was on a par with Netscape, and it started the browser war.” A decision to include email, news readers and a WYSIWYG web page compositor in Netscape Navigator 3.0 Gold Edition backfired because the software would frequently crash.



ABOVE The Netscape logo was introduced in 1994



ABOVE An installation disk for an early version of Netscape Navigator

Netscape’s standards dropped further and, on 28 September 1998, a report from the International Data Corporation (IDC) showed that Internet Explorer had 48.3% of the market, leaving Netscape Navigator with 41.5%. IDC research manager Joan-Carol Brigham said it showed a dramatic shift, and the situation only worsened for Netscape.

It had been easier for Windows users to simply use the built-in browser than search for an alternative, especially in the days when downloading would, as already suggested, take an age. The situation led to a federal antitrust suit against Microsoft, but Internet Explorer nevertheless ended up taking a market share of 95% at its peak.

“Netscape didn’t seem to have a very sustainable business model, and

it had to compete with a free product from Microsoft, which had lots of money and used [its] dominance in the operating system side to Netscape’s disadvantage,” lamented Lannerö. “Netscape tried to make money on web server software, HTML editing features (Navigator Gold) and more products than I can remember, but this never worked out.”

Even so, Netscape’s legacy is secure. In

Clark, it had a genius entrepreneur – someone who kept abreast of technology – and in Andreessen it had an innovative software engineer. Together they created a company that turned technology and business on its head. “It probably paved the way for the dotcom bubble,” Lannerö said. It also, Lewis asserted, turned Silicon Valley into “the source of changes taking place across society”.

Netscape was acquired by AOL by 1999 but the company was defunct by 2003 even though versions of the browser continued to be released, ending with Netscape Navigator 9 in 2008.

“I believe the company’s

commercial assets (websites, customer registers, patents and so on) were eventually bought by some other company with better finances and a desire to grow, while the browser platform was donated to the web community as open source,” said Lannerö. “This led to Firefox, which is still alive and popular for its openness and privacy features.” ●

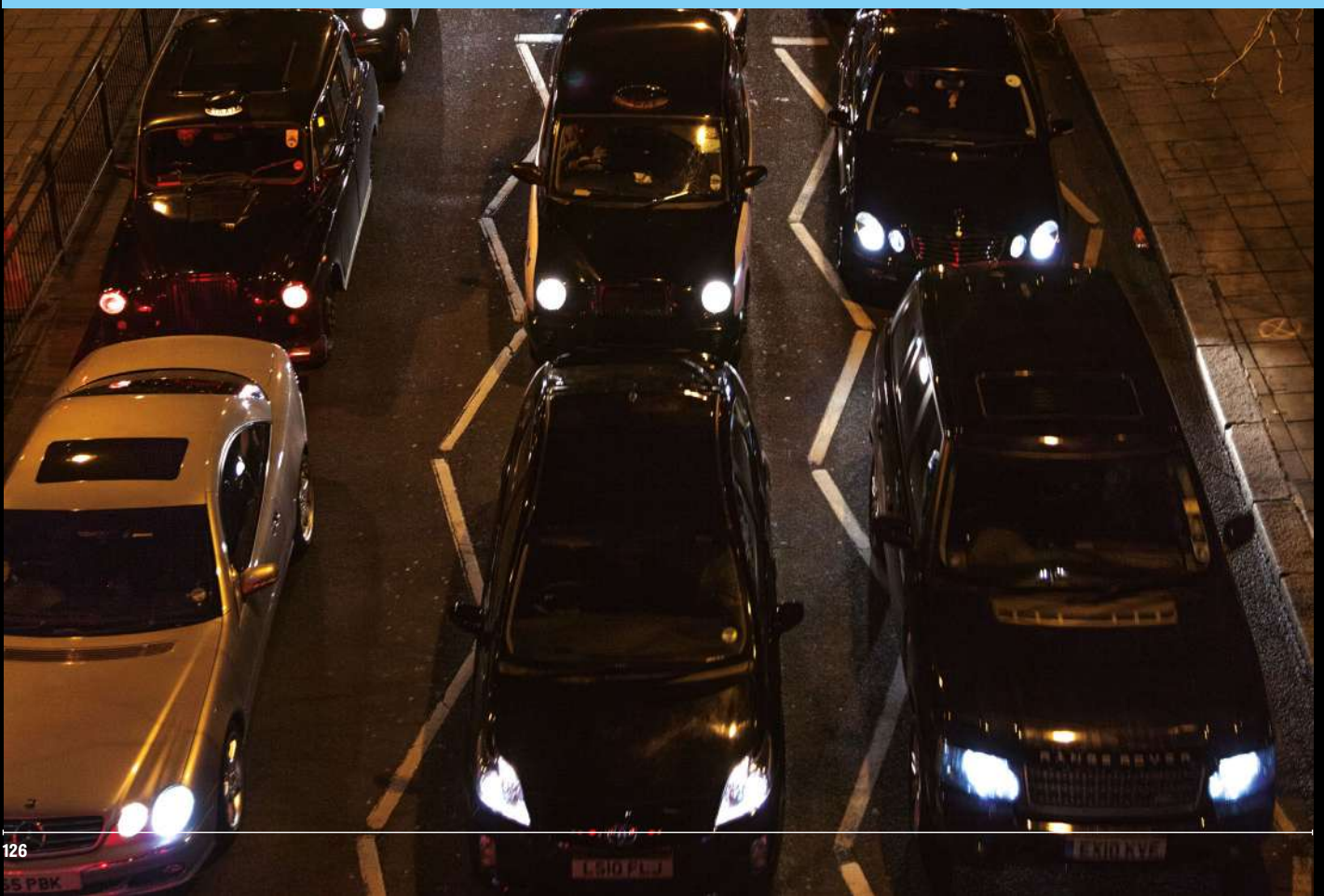
Futures

We explore the trends and technologies that are set to shape the future



Can tech kill off cars in cities?

Rent a bike with an app. Order groceries with robot deliveries. Ditch the train for a flying car. Could these future technologies help clean up city transport? [Nicole Kobie](#) travels into the future



The average speed for a car travelling across London is 10mph; for buses, it's closer to 9mph. That's the same as a horse-drawn carriage in 1908. Why? Traffic. Too many of us drive, and that causes problems for everyone else driving a car – as well as those who suffer the downsides of cars, be it clogged roads holding up bikes and buses, or emissions causing dangerously poor air quality while exacerbating climate change.

Policies to reduce car use have become fodder for the tabloids' culture war – ideas such as modal filtering or LTNs (low-traffic neighbourhoods), road pricing such as London's congestion zone, and air quality rules like the ULEZ are all deemed battles in the so-called "war against cars". Setting aside the politics, all of these traffic-control techniques are possible without tech, but they're often monitored with number-plate reading cameras, automated ticketing systems and so on.

And there's more that tech could do to help – at least, that's what Transport for London (TfL) hopes. It has three goals for 2041: net zero (no carbon emissions); vision zero (no deaths on the network); and to hit a milestone of 80% of journeys in the city taken on public transport or via active

travel, such as walking or cycling. To achieve that, said Thomas Ableman, TfL's director of strategy and innovation, speaking at the Move conference in June, car journeys must fall by half from 36% of trips now. "It's a huge amount of change in the way people move around our city," he said.

With such tough goals, TfL is happy to look at any innovation that could help, but won't invest in anything that doesn't "move us closer to that goal", said Ableman. He says trials suggest e-scooter and e-bike rentals will likely help Londoners ditch cars and reach net zero, but on-demand buses won't.

Autonomous cars could help with the net zero goal, Ableman says, but they won't drive that shift to public or active transport. While he sees the technology as having potential with buses or perhaps on-demand transport, Ableman notes that the "robo taxi" business model is contrary to the wider aim to reduce single-occupancy vehicles. "One thing I would say to anyone who is involved in the world of autonomous vehicles is please consider whether autonomous vehicles move us towards 80% mode share for public transport and active

travel." He added that in terms of innovation the technology is notable, but might not help make cities better.

Working with tech companies could help, he adds. TfL invested £350 million in cycle paths, but people weren't being directed to them on wayfinding apps. "We spoke to the entire ecosystem of app providers... and said how can we fix this, and Google has done an amazing job working really collaboratively with us on trying to solve that, and has now filled out an entirely new algorithm worldwide as a direct result of the feedback we gave them," he explained.

At that Move conference, speakers from across industry and government revealed a host of other ways that mainstream gadgets and cutting-edge

offer a cheaper alternative to taxis for people who need help or can't reach a local bus stop. And they can act as a way to get people who don't like buses using something very much like a bus.

What works in the Midlands might not work everywhere, however.

"It's all about delivering a hybrid service between bus and taxi. What happens when you have flexibility, how does it change travel?"

Ableman noted that DRT trials weren't continued in London. "The problem with DRT is it's phenomenally expensive," he said. "It was a good-quality product, and people liked the DRT... but what it didn't do was

provide that service cost-effectively." How expensive was it? According to Ableman, it cost an "order of magnitude" more than a conventional bus, largely because of the smaller vehicles. And people weren't ditching cars for DRT, but buses. "It wasn't really achieving the mode shift goal – the majority of people who were using it were existing public transport users." So it wasn't deemed viable or scalable, in London at least.

It's worth noting, as Ableman said, that London has one of the densest bus networks in the world. And there are plenty of rural areas that lack bus services at all, where on-demand options could have real potential.

■ eVTOLs vs trains

Trains used to criss-cross the country, but no longer. Now, taking public transport to get from the east to the

ON-DEMAND TRANSPORT



LEFT Demand-responsive transport is a hybrid service between taxis and buses that can be summoned by app

technologies were being used to encourage people out of their cars to get on their bikes, take a walk or hop on a bus. Ideas such as smart apps, AI-powered analytics and flying cars are all under consideration, though whether any of those will work remains to be seen. In the meantime, let's take a trip through the future of city roads.

■ On-demand transport

Demand-responsive transport (DRT) is the industry term for what is essentially on-demand buses, or mini buses. You tap that you'd like a ride in the app and are told a meeting point and time. The vehicle picks you up and drives you to your destination, but makes other pickups and drop-offs along the way, with routes organised and optimised by algorithms.

"It's all about delivering a hybrid service between bus and taxi," said Mark Collins, head of future transport at Transport for West Midlands. "What happens when you have flexibility, how does it change travel?"

Such ideas can help supply coverage in transport deserts, providing public transport to people in rural areas without scheduled services. They can

RIGHT Finally, flying cars – or electric vertical take-off and landing aircraft – may become a reality



eVTOLs vs TRAINS

west can involve an onerous journey into London and back out again, which is expensive, wasteful and adds to traffic in the capital. That means many people opt to drive instead.

What if there was another option? It's unlikely the Beeching cuts of the 1960s are going to be undone and new rail laid to solve the problem. But there could be another solution: eVTOLs. These are electric vertical take-off and landing aircraft, sometimes referred to as "flying cars". ➔

Rather than hopping in a single-passenger, petrol-burning, emissions-spewing car for a multi-hour journey, travellers could hop the bus to the local vertiport – perhaps at a disused airfield, maybe atop the local train station – and be whizzed cross-country in a fraction of the time in a quiet, clean, electric aircraft.

“Most of us know in the UK that our transport network is designed north to south,” said Andrew Chadwick, ecosystem director for Air Mobility and Airports at Connected Places Catapult. “If you live east or west you need a car.”

However, there are 500 disused or little-used airfields scattered about the country. “They’re at risk of being turned into housing estates or Amazon warehouses,” he said.

Instead, they should be rejuvenated for eVTOL services, acting as the starting point of a network of vertiports linking towns and cities, without needing a car or a long ride to London. “There’s a great opportunity here, I think,” he said.

Jeremy Hartley, policy specialist for vertiports at the Civil Aviation Authority, agreed that regional trips could be a key market in the UK. “Our cities aren’t that far apart, a lot of these aircraft can fly up to 150 miles,” he said. Right now, going from Chelmsford to Harlow by train is an

irritating hour-plus trip into London and back out again; in a car, it’s 40 minutes. In the air, in an eVTOL, it would be less than 20 minutes. And, the speakers said, they expect it to cost about as much as taking a taxi.

The idea will be tested later this year at Bicester airfield, with a vertiport to show off the idea and, hopefully, even flight demonstrations with Vertical Aerospace, Hartley says. “The intent is to fly some things.”

■ Last-mile delivery

You come home from work and are about to make dinner. But you lack onions. What do you do? Walk to the corner shop? But what about the kids? Cram them in the car and schlep to the big Tesco? Ugh. Go without? Probably the most likely option.

But what if a small rolling robot brought you onions with a few taps of an app? That’s the idea behind Starship Technologies’ (mostly) autonomous robots, which are being trialled by Cambridgeshire County Council. Starship vice-president Lisa Johnson said replacing a run to the shop is “the majority of what we do in Europe”. (Of course, similar on-demand groceries

services already exist using people on bikes, but hey, robots work as well.)

Then there are drones. The idea has been kicking around for years, but largely remains grounded. That said, they have been trialled for long-range deliveries of medicine and medical equipment, so the technology works. It might make more sense in rural areas, taking delivery trucks and scooters off the road – it would be great if your delivery dinner could take a more direct route overhead and arrive while still hot, too.

Dave Pankhurst, director of drones at BT Group, said there’s already a huge volume of drone deliveries happening globally every day through Google’s Wing or rival Manna. “It is viable, but we need to find that

freedom, it’s status, it’s everything you want in your life. Public transport is the opposite,” he said.

So how can transport providers ensure they offer the right alternatives that people want to use while also

communicating in a way that’s appealing? They need data. “From what we see, the biggest barrier... is the lack of knowledge of behaviour patterns,” said Adam Ejsmont of Echo Analytics. “You can’t

design a good system if you don’t know what will drive adoption.”

That means cities looking to make a change need to understand the latent demand for micromobility, bike lanes and bus routes. And that means collecting data, analysing it correctly, and coming up with real answers.

Cities such as London have some of this information, but unpicking what it all means may require serious modelling, perhaps turning to AI to help. In the meantime, we’re stuck with small trials of ebikes and the like that may fail simply because they don’t offer wide enough availability or coverage.

In the Midlands, Collins agrees that there’s a lack of data on what people want from transport, and what would encourage them out of cars. “We need to understand what is driving behaviour so they choose public services,” he said. “We don’t have a collective piece around how people

“It’s all well and good saying we want to reduce car ownership... but is the alternative attractive?”

LAST-MILE DELIVERY



LEFT Robots could be used to deliver your groceries, negating the need for a trip to the shops in your car

balance... between what makes more sense on the ground and in the air.”

■ Big data for big change

Convincing people to change their ways isn’t easy. But there are lots of places where public transport and active travel far outweigh cars. For example, said Isaac Ng from MTR Lab, Hong Kong has one of the lowest car ownership rates in the world. “One of the really key things in reducing car ownership is [offering an] alternative,” he told conference attendees. “It’s all well and good saying we want to reduce car ownership... but is the alternative attractive?”

In the UK, perceptions of public transport are that it isn’t reliable, safe or clean. That’s not the case in Hong Kong. Trains are much more reliable than fighting traffic. “On a Friday afternoon, if you took a taxi, you’d be called a fool,” he said.

While improving services is an obvious answer, Chris de Veer, mobility innovation manager at Amsterdam Smart City, says that public transport and bikes need better marketing. “The car industry has been marketing this for years – it’s

RIGHT Bike lanes can help ease congestion, but only if their installation is based on the right data



BIG DATA FOR BIG CHANGE

are influenced by transport.” He called for the Department for Transport to pool knowledge around behaviour to build up “a level of intelligence”.

After all, technology companies manage to collect plenty of data about us to advertise services and products. Why not copy that idea to better understand transport demand? Until such a data pool can be created, Collins says there’s a simple way forward: “People get on the bus when it works... that changes behaviour.” ●

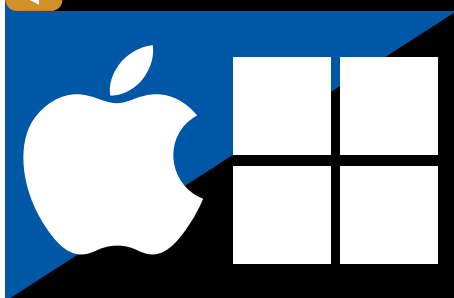
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Next month

ON SALE

Thursday 5 September

Features



Windows & macOS: what's new

Every autumn brings a fresh batch of features to Windows and macOS. We gain early access to see what's great and what's instantly forgettable.

Features



Cyberspace oddity

Lee Grant delves into the story behind BowieNet, an extraordinary internet service provider created by the star man himself.

Features



Turn an old router into a Wi-Fi extender

Darien Graham-Smith shows how it's done, with guides for every major brand.

Labs

Workstations

Look out for our appetite-whetting test of eight cutting-edge graphics workstations next month, as we put the very latest and most powerful hardware to the test.



Retro

Steve Jobs & NeXT

After leaving Apple, Jobs hoped to make a big impact making computers for education. But NeXT ended up teaching the computer industry a thing or two instead.



The Network



Remote support software

We explain what businesses should look for when investing in remote support software, and put four of the best products to the test.

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It's too big, too heavy and too expensive – but the Vision Pro is also too wonderful, says Jon Honeyball

When I first saw the seminal film *Blade Runner*, there was a moment when I felt a shiver run down my spine: when Roy Batty said, “I’ve seen things you people wouldn’t believe. Attack ships on fire off the shoulder of Orion. I watched C-beams glitter in the dark near the Tannhäuser Gate. All those moments will be lost in time, like tears in rain.” In those few words, Batty opened up a galaxy of the unknown.

The only appropriate response to something this new is to stop. To take stock of what you have just seen, and then attempt to both put it into context and see where it will take us. Even now, I can remember the philosophical effect *Blade Runner* had on me and my thinking.

Exactly the same thing happened earlier this week, when my Apple Vision Pro was delivered.

Over the past 30 years, as celebrated in this month’s magazine, we have progressed from desktop computing to laptops to mobiles to wearables. It’s felt like a giddy headlong rush, but all of these devices really only work in 2D, offering some sense of 3D at best. Even then, the 3D you get is mostly “front plus everything else”.

And applications have stuck with this model, because it works on the majority of devices. Take Microsoft Office. I don’t have any issues with Word being absolutely locked into a 2D world, because its underlying nature is that of a sheet of paper. Excel is different, yet we’re still stuck in two-dimensional thinking despite so much data having at least one extra dimension to it. Sales figures by region by month are three to start with. Lotus Improv tried to square that circle – flatten that orb? – by bringing a multidimensional

hierarchy to your data, even though it presented it in a 2D world.

Apple’s Vision Pro could finally break us free from this 2D flat-earth thinking. I don’t mean those awful 3D televisions, or the even worse cinema 3D experiences; I’m talking properly implemented, full-depth 3D. Something that is so good, so well implemented and rounded, that you can’t help but gasp.

Suddenly we have a display and compute platform that isn’t restricted to two planes. Which doesn’t demand conventional methods of interaction such as keyboards and mice. Where applications can generate a truly lifelike, solid set of interfaces and controls where you can simply reach out and touch them.

Of course, the first thing I did was fire up Excel and marvel at just how prehistoric it is. But I can bring up all sorts of apps, and place them around me, either in a truly lifelike augmented reality environment of the space where I am sitting, or virtually transported to somewhere else on the planet.

I can’t explain just how big a deal this is. To break free from 40 years of flat-plane thinking. Suddenly video is 3D, and truly immersive and convincing. Even video shot on my iPhone 15 Pro Max in Vision Pro mode is compelling, and vastly better than conventional 2D video.

The AR stuff just works. If you have an app that can interact with objects around you, it can be hilarious fun. I have one that lets me take photos and place them onto vertical objects such as kitchen cabinets. I spent a highly enjoyable hour redecorating my kitchen, and noted with glee how everything stayed in place as I walked around.

The scope of what Apple has achieved cannot be underestimated. No, it isn’t ready for prime time. It’s too heavy, it’s much too expensive, and the battery life is too short. There is a limited, albeit slowly growing, range of native AVP apps. And while Apple is iterating at super high speed on the base OS and this device’s capabilities, some of the betas are wobbly. There won’t be a more end-user focused product until the end of next year.

All of these are valid criticisms. And I don’t give a damn, because I’ve seen a vision of the future and it’s glorious. Not for every task

“Apple’s Vision Pro could finally break us free from 2D flat-earth thinking. Something that is so good, so well implemented and rounded, that you can’t help but gasp”

everywhere. But for some tasks, just like I use my watch for some things, my phone for others, and a multi-monitor setup on a desktop when I need to work on huge Excel tables. Everything has a place, and there is a place for everything.

If you have an ounce of curiosity, then book a free 30-minute demo at your local Apple Store. Go in with an open mind, be transfixed by what you see, but then consider what this can do moving forward. A different place to show flat Excel sheets isn’t the future. But don’t come up with a better answer, redefine the question.

For me, the Vision Pro redefines questions that I have been pondering for the whole of my lifetime.

■ Jon Honeyball has been a contributing editor to *PC Pro* since issue one. He looks even more handsome with a Vision Pro strapped to his head. Email jon@jonhoneyball.com



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